Stellarium - používateľská príručka

Matthew Gates, Michal Domonkos

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Obsah

Kapitola 1

Úvod

Stellarium je softvérový projekt, ktorý umožňuje použit' stolný počítač ako virtuálne planetárium.

Vypočítava a vykresluje Slnko, Mesiac, planéty, hviezdy a iné vesmírne objekty tak, ako by ich používatel' videl, keby sa pozeral na oblohu z daného miesta v danom čase. Program je schopný vykreslit' i konštelácie a simulovat' astronomické fenomény ako meteory, zatmenie Slnka či Mesiaca atd'.

Stellarium môže byt' použité ako výukový softvér, pomôcka pre amatérskych astronómov plánujúcich si večerné pozorovanie oblohy, či len tak pre zaujímavost' a zábavu. Vd'aka kvalite vykreslovanej grafiky je Stellarium používané ako súčast' profesionálnych projektorov pre niektoré reálneplanetária. Používa sa i na vytváranie máp oblohy a ilustrácií v astronomických magazínoch.

Stellarium sa neustále poctivo vyvíja a v čase písania tejto príručky už môžu existovat' novšie verzie, takže niektoré vlastnosti programu opísané v tejto príručke už nemusia byt' aktuálne. Pre aktualizácie navštívte stránku Stellaria. alebo Stellarium fórum.

Poznámky pre verziu 0.10.0

Tento dokument popisuje verziu 0.10.0 programu Stellarium. Táto verzia prináša mnoho vel'kých zmien - či už štruktúry zdrojových súborov programu alebo vonkajšieho vzhl'adu. Najvýraznejšiou zmenou od sérií 0.9.x je nové pouužívatel'ské rozhranie.

Z dôvodu rozsahu zmien v tejto verzii niektoré vlastnosti starších verzií nie sú v tomto dokumente zahrnuté, pretože čakajú na novú implementáciu konzistentnú s novou štruktúrou programu. Konkrétne ide o tieto vlastnosti:

- Skriptovací engine
- Textové používatel'ské rozhranie (TUI)
- Klávesy na ovládanie teleskopu

Pretože tieto vlastnosti sú dôležité pre mnoho používatel'ov, označili sme túto verziu ako *beta*. Ide skutočne iba o poznámku, ktorá indikuje, že chýbajúce vlastnosti budú doplnené čoskoro.

Kapitola 2

Inštalácia

2.1 Systémové požiadavky

- Linux/Unix; Windows 2000/NT/XP/Vista; MacOS X 10.3.x alebo vyššie.
- 3D grafická karta s podporou OpenGL.
- Tmavá miestnosť pre realistický zážitok. Detaily ako Mliečna dráha alebo mihanie hviezd nie sú viditeľné v svetlej miestnosti.
- Aspoň 256 MiB RAM, 1GiB alebo viac je potrebný pre najväčšie katalógy telies.

2.2 Stiahnutie

Navštívte LINK. Balíky pre rôzne platformy sú dostupné priamo z hlavnej stránky. Vyberte si správny balík pre váš operačný systém [1].

2.3 Inštalácia

2.3.1 Windows

1. Dvojkliknite na súbor stellarium-0.9.1.exe, spustí sa inštalačný program.
2. Riaďte sa pokynmi inštalačného programu.

2.3.2 MacOS X

1. Nájdite súbor stellarium-0.9.1.dmg a dvojkliknite naň alebo použite program disc copy.
2. Prejdite si súbor readme a presuňte Stellarium do adresára Aplikácie (alebo inde, kam si prajete).
3. Je lepšie skopírovať Stellarium z .dmg súboru a spustiť ho až potom. Niektorí používatelia hlásili problémy so spúšťaním Stellaria priamo z .dmg súboru.

[1] Používatelia Linuxu, vaša distribúcia môže obsahovať Stellarium ako svoju súčasť - presvedčte sa o tom vo vašom správcovi balíkov.

2.3.3 Linux

Skontrolujte si, či vaša distribúcia neposkytuje balík Stellaria. Ak áno, stačí ho nainštalovať pomocou vášho nástroja na pridávanie a odstraňovanie softvéru. V opačnom prípade si môžete Stellarium skompilovať zo zdrojových kódov. Pre bližšie informácie o kompilovaní, pozrite si našu stránku.

2.4 Spustenie Stellaria

Windows Inštalátor Stellaria vytvorí v ponuke Štart a sekcii Programy svoj odkaz. Kliknite na tento odkaz a spustite Stellarium.

MacOS X Dvojkliknite na Stellarium (kdekoľvek sa nachádza).

Linux Ak vaša distribúcia má balík Stellaria, pravdepodobne nájdete odkaz na nainštalované Stellarium v Gnome alebo KDE menu. Ak nie, stačí, ak otvoríte terminál a napíšete stellarium.

Kapitola 3

Používateľské rozhranie

Obrázok 3.1: Zložený snímok z prostredia Stellarium zobrazujúci dennú a nočnú oblohu

3.1 Prehľad

Na spodku obrazovky môžete vidieť stavovú lištu. Táto ukazuje aktuálnu polohu pozorovateľa, zorné pole (FOV), grafický výkon v rámcoch za sekundu (FPS) a súčasný dátum a čas simulácie.

Zbytok plochy je vyhradený na vykresľovanie realistickej scény vrátane panoramatickej krajiny a oblohy. Ak sú čas simulácie a poloha pozorovateľa také, že v skutočnosti je noc, uvidíte na oblohe hviezdy, planéty a Mesiac, všetko v správnej polohe.

Meniť smer, ktorým sa pozeráte, môžete pomocou myši tak, že kliknete na plochu a posuniete kurzor. Takisto je možné ovládať oblohu pomocou kurzorových klávesov. Približovať pohľad môžete pomocou myši alebo klávesov page up/page down.

Keď prejdete kurzorom myši nad stavovou lištou, zobrazí sa nástrojová lišta, ktorá vám poskytne rýchlu kontrolu nad programom.

3.1.1 Cestovanie v čase

Stellarium vám umožňuje sledovať oblohu v ktoromkoľvek čase (v minulosti i budúcnosti) a interaktívne sa v ňom pohybovať.

Štandardne plynie čas reálnou rýchlosťou. Kliknutím na tlačidlo alebo sa plynutie času zrýchli resp. spomalí. Ďalším kliknutím na toto tlačidlo sa rýchlosť plynutia času opäť zvýši resp. zníži. Pri malých rýchlostiach plynutia času nie je hneď vidno meniacu sa oblohu, no pri dostatočnej rýchlosti sa hviezdy začnú pohybovať a uvidíte napríklad i zapadajúce a vychádzajúce Slnko.

Keď sa chcete vrátiť k normálnemu plynutiu času, kliknite na tlačidlo . Pre nastavenie aktuálneho času a dátumu kliknite na tlačidlo .

Tlačidlo	*Klávesová skratka*	*Popis*
	j	Znížiť rýchlosť plynutia času
	k	Normálne plynutie času
	l	Zvýšiť rýchlosť plynutia času
	8	Vrátiť sa k aktuálnemu času a dátumu

Tabuľka 3.2: Tlačidlá lišty na ovládanie času

3.1.2 Pohybovanie sa na oblohe

Klávesa	*Popis*
Kurzorové klávesy	Otáčať pohľad vľavo, vpravo, hore a dole
Page up / Page down	Priblížiť a vzdialiť
Backslash (\)	Automatické vzdialenie na pôvodné zorné pole
Left mouse button	Vybrať objekt na oblohe
Right mouse button	Zrušiť vybraný objekt
Mouse wheel	Priblížiť a vzdialiť
Space	Vycentrovať pohľad na vybraný objekt
Forward-slash (/)	Automatické priblíženie na vybraný objekt

Takisto ako pohyb v čase umožňuje Stellarium i voľné pozorovanie oblohy, otáčanie sa okolo osí, približovanie a vzďaľovanie.

Pohyb sa vykonáva pomocou kurzorových klávesov alebo myši. Klávesa Page Up priblíži oblohu, Page Down ju vzdiali. Keď sa chcete vrátiť k pôvodnému priblíženiu, stlačte klávesu Backslash. Takisto pomocou myši sa môžete pohybovať po oblohe kliknutím ľavým tlačidlom a posunutím.

Inou metódou je označenie objektu na oblohe (ľavým tlačidlom myši). Označte objekt a stlačte klávesu Space na vycentrovanie pohľadu na tento objekt. Podobne označením objektu a stlačením klávesy predného lomítka vycentrujete pohľad na objekt a zároveň ho priamo priblížite. Ak sa jedná o objekt, ktorý je napr. planétou s mnohými mesiacmi, priblíženie sa vykoná do takej miery, aby boli všetky tieto objekty viditeľné zároveň.

3.1.3 Hlavná nástrojová lišta

Obrázok 3.2: Ukážka niektorých efektov programu Stellarium

Ako máte možnosť vidieť na obrázku, Stellarium dokáže viac, než len vykresľovať hviezdy. Zobrazuje konštelácie, informácie k planétam, atmosférické efekty ako opar okolo Mesiaca na jasnej oblohe a pod.

Ovládacie prvky na hlavnej nástrojovej lište umožňujú zapínať a vypínať tieto vizuálne efekty. Pre podrobnejšie informácie, sledujte tabuľku.

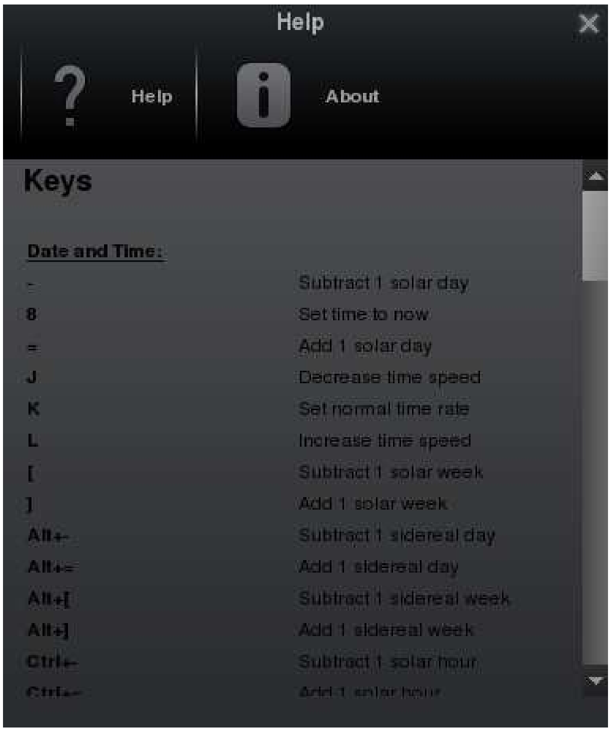
Vlastnosť	*Tlačidlo na lište*	*Klávesa*	*Popis*
Konštelácie		c	Vykreslí čiary konštelácií
Názvy konštelácií		v	Vykreslí názvy konštelácií
Ilustrácie konštelácií		r	Prekryje hviezdy umeleckými reprezentáciami konštelácií
Rovníková mriežka		e	Vykreslí čiary pre súradnicový systém RA/Dec
Azimutálna mriežka		z	Vykreslí čiary pre súradnicový systém Alt/Azi
Prepnúť krajinu		g	Prepína zobrazenie krajiny. Vypnite toto vykresľovanie, keď chcete sledovať objekty pod horizontom
Prepnúť kardinálne body		q	Prepína zobrazenie označenia severu, juhu, východu a západu
Prepnúť atmosféru		a	Prepína atmosférické efekty. Umožňuje vidieť hviezdy počas dňa
Hmloviny & galaxie		n	Prepína zobrazenie hmlovín a galaxií, keď FOV je príliš široký
Popisky planét		p	Prepína indikátory na zobrazenie polohy planét
Súradnicový systém		Enter	Prepína medzi súradnicovými systémami RA/Dec a Alt/Azi
Prejsť na		Space	Vycentruje pohľad na vybraný objekt
Nočný režim		[none]	Prepína nočný režim, ktorý zmení farby rozhrania tak, aby boli menej namáhavé pre oko adaptované na tmu
Celoobrazovkový režim		F11	Prepína celoobrazovkový režim
Preklopiť obraz (horizontálne)		CTRL+SHIFT+h	Preklopí obraz podľa horizontálnej roviny. Táto funkcia nie je povolená defaultne, pozrite sekciu**??**
Preklopiť obraz (vertikálne)		CTRL+SHIFT+v	Preklopí obraz podľa vertikálnej roviny. Táto funkcia nie je povolená defaultne, pozrite sekciu**??**
Vypnúť Stellarium		CTRL-Q	Opustiť program Stellarium. Na OSX počítačoch je to skratka COMMAND-Q
Okno pomocníka		F1	Zobraziť okno pomocníka, ktoré obsahuje zoznam klávesových skratiek a iné užitočné informácie
Konfiguračné okno		F2	Zobraziť konfiguračné okno
Vyhľadávacie okno		F3 or CTRL+f	Zobraziť vyhľadávacie okno
Okno pohľadu		F4	Zobraziť okno pohľadu

3.1.4 Okno na vyhľadávanie objektov

Okno na vyhľadávanie objektov poskytuje jednoduchý spôsob, ako sa nechať Stellariom naviesť na vybraný objekt na oblohe. Stačí do textového poľa zadať neúplny názov hľadaného telesa a program vám poskytne zoznam objektov zo svojej databázy, ktoré vyhovujú zadaným začiatočným písmenám. Stlačením klávesy TAB sa výber presunie na ďalší objekt v zozname.

Takže ak presne neviete, ako sa požadovaný objekt volá, stačí, ak zadáte iba začínajúce písmená a budú vám ponúknuté celé názvy. Potom už stačí iba stlačiť ENTER a budete nastavení na daný objekt.

3.1.5 Okno pomocníka



Obrázok 3.3: Okno pomocníka

Okno pomocníka obsahuje zoznam klávesových skratiek programu Stellarium. Všimnite si, že niektoré funkcie sú dostupné len prostredníctvom klávesových skratiek, takže je dobré si informácie v tomto okne preštudovať.

Záložka O programe zobrazuje licenčné informácie a zoznam ľudí, ktorí pomohli vyvinúť tento program.

Kapitola 4

Konfigurácia

Väčšina nastavení v Stellariu sa vykonáva prostredníctvom konfiguračného okna. Otvoríte ho kliknutím na ikonu na ľavej nástrojovej lište alebo stlačte F2. Okno pohľadu otvoríte kliknutím na ikonu na ľavej nástrojovej lište alebo stlačte F4.

Niektoré nastavenia sa dajú vykonať iba editáciou konfiguračného súboru.

4.1 Nastavenie času a dátumu

Okrem tlačidiel kontroly rýchlosti plynutia času na hlavnej lište môžete nastaviť čas simulácie v okne času a dátumu (obrázok 4.1). Hodnoty roku, mesiaca, dňa, hodiny, minúty a sekúnd sa dajú zmeniť napísaním nových hodnôt, kliknutím na šípky po jednotlivými hodnotami, alebo použitím kolečka na myši.[1]

4.2 Nastavenie vašej polohy

Na to, aby Stellarium bolo schopné zobraziť oblohu presne tak, ako by ste ju videli zo svojej stoličky, keby ste sa na ňu teraz pozreli je nutné okrem času správne si nastaviť polohu.

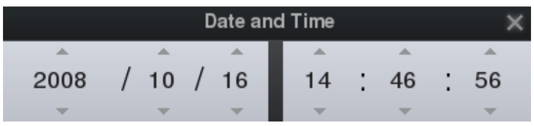
Pre nastavenie vašej aktuálnej polohy, stlačte F6 na otvorenie okna polohy (4.2). Sú nasledujúce možnosti, ako to urobiť:

1. Nastavte si polohu kliknutím na príslušné miesto na mape. Toto je však pomerne nepresná a zdĺhavá metóda.

2. Ak viete zemepisné súradnice vašej polohy (napr. pomocou GPS), zadajte ich do príslušných políčok.

3. Na záložke Terén (Landscape) zaškrtnite "Nastavenie terénu aktualizuje polohu" a vyberte si nový terén. Poloha bude potom nastavená podľa príslušného terénu.

[1] Vo verzii 0.10.0 je časová zóna prevzatá z prostredia operačného systému.



Obrázok 4.1: Okno času a dátumu

Keď ste už spokojný s úpravami, kliknite na tlačidlo "Uložiť polohu" a zavrite konfiguračné okno.

4.3 Konfiguračné okno

Konfiguračné okno obsahuje všeobecné nastavenia programu a mnoho ďalších nastavení, ktoré nesúvisia so zobrazením.

Hlavná záložka v konfiguračnom okne**??** poskytuje možnosť zmeniť jazyk programu, množstvo informácií zobrazených pri vyznačených objektoch a tlačidlo na uloženie aktuálnej konfigurácie programu.

Záložka navigácie**??**umožňuje povoliť či zákazať klávesové skratky na panoramatický pohyb, približovanie hlavného pohľadu a takisto špecifikovať čas simulácie, ktorý sa má použiť po spustení programu.

- Keď je vybratá možnosť “Systémový čas a dátum”, Stellarium sa spustí použítím informácie o čase z operačného systému.
- Keď je vybratá možnosť “Systémový dátum”, Stellarium sa spustí s aktuálnym systémovým dátumom, no bude použitý špecifikovaný čas. Táto možnosť je užitočná pre tých, ktorí si počas dňa plánujú pozorovacie aktivity na večer.
- Keď je vybratá možnosť “Ostatné”, Stellarium sa spustí so špecifikovaným časom a dátumom.

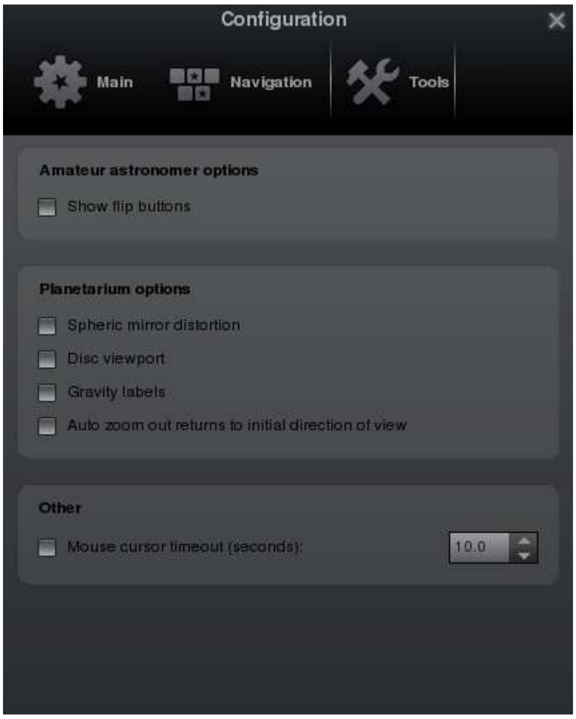
Záložka nástrojov v konfiguračnom okne**??** obsahuje rôzne funkcie:

Zobraziť_tlačidlá_na_zrkadlenie Táto možnosť pridá na hlavnú nástrojovú lištu dve tlačidlá na prepínanie zrkadlového obrazu oblohy v horizontálnom i vertikálnom smere. Táto možnosť je užitočná pri pozorovaní cez teleskopy, ktoré výsledný obraz zobrazujú prevrátený.

Skreslenie_sférickým_zrkadlom Táto možnosť zdeformuje hlavný pohľad tak, aby mohol byť premietnutý na sférické zrkadlo použitím projektoru. Výsledný obraz bude odrazený zo sférického zrkadla takým spôsobom, že sa da premietnuť na malú kupolu vytvárajúc tak lacný systém premietania pre planetárium.


Configuration
Main
Navigation
Tools
Program language
English (UnitedKingdom)
Selected object information
All available
Short
None
Default options
Save current options as default
Save all the current options including the current FOV and direction of view for use at next startup.
Startup FOV: 0.167722°
Startup direction of view Az/Alt: +179°59'58"/+11°18'36"


Configuration
Main
Navigation
Tools
Control
Enable keyboard navigation
Enable mouse navigation
Startup date and time
System date and time
System date at: 21:00
Other: 01/12/1999 18:00



Kotúčové_zorné_pole Táto možnosť zakrýva časť hlavného pohľadu vytvárajúc tak efekt okuláru teleskopu. Je to užitočné aj na projekciu výstupu zo Stellaria, ktorá používa planetáriový projektor so šošovkou typu rybie oko.

Gravitačné_popisky Táto možnosť zarovná popisky k objektom v hlavnom pohľade s najbližším horizontom. To znamená, že popisky premietané na kupolu budú vždy zarovnané správne.

Automatické_odďaľovanie_resetne_aj_zorné_pole Táto možnosť umožňuje zmeniť správanie klávesy na odďaľovanie pohľadu (\) tak, že okrem resetnutia počiatočného smeru pohľadu resetne aj zorné pole.

4.4 Okno nastavenia pohľadu

Okno nastavenia pohľadu umožňuje nastaviť rôzne zobrazovacie možnosti Stellaria, ktoré nie sú dostupné cez hlavnú lištu.

4.4.1 Záložka oblohy

Záložka oblohy v okne pohľadu**??**obsahuje nastavenia na zmenu všeobecného vzhľadu hlavného pohľadu na oblohu. Niektoré z nich sú:

Absolútna_mierka je veľkosť hviezd zobrazených Stellariom. Ak zvýšite túto hodnotu, všetky hviezdy sa budú javiť väčšie ako predtým.

Relatívna_mierka určuje rozdiel vo veľkosti jasných hviezd v porovnaní so slabými. Hodnoty vyššie ako 1.00 urobia najjasnejšie hviezdy väčšie, ako sú na oblohe v skutočnosti. Toto je užitočné na vytváranie mapy hviezdnej oblohy alebo pri učení sa základných konštelácií.

Ligotanie určuje, ako veľmi hviezdy blikotajú.

Dynamické_prispôsobenie_oka When enabled this feature reduces the brightness of faint objects when a bright object is in the field of view. This simulates how the eye can be dazzled by a bright object such as the moon, making it harder to see faint stars and galaxies. Táto možnosť znižuje jas slabých objektov, keď sa v zornom poli nachádza jasný objekt. Toto simuluje, ako môže byť oko oslepené jasným objektom ako napr. Mesiac, čo spôsobuje ťažšie pozorovanie slabých hviezd a galaxií.

Svetelné_znečistenie V zastavaných oblastiach je obloha ožiarená pozemnými zdrojmi svetla, ktoré sa odráža v atmosfére. Stellarium tento efekt simuluje a je kalibrovaný pomocou *Bortlovej mierky tmavej oblohy*, kde 1 označuje dobrú tmavú oblohu a 9 veľmi svetelne znečitenú oblohu. Pozri sekciu5.6.1pre ďalšie informácie.

Planéty_a_satelity Táto skupina možností vám umožňuje zapnúť alebo vypnúť rôzne vlastnosti súvisiace s planétami. Simulácia rýchlosti svetla dáva väčšiu presnosť pri polohovaní planetárných telies, ktoré sa pohybujú rýchlo oproti hviezdnemu pozadiu (napr. mesiace Jupitera). *Zväčšiť mesiac* zvýši zdanlivú veľkosť mesiaca na oblohe, čo môže byť užitočné na širokouhlé zábery.

Popisky_a_značky Môžete nezávisle zmeniť množstvo popiskov zobrazených pre planéty, hviezdy a hmloviny. Čím viac sú posuvníky nastavené doprava, tým viac popiskov uvidíte. Všimnite si, že viac popiskov sa zobrazí takisto pri priblížení.

Meteory Stellarium poskytuje možnosť na jednoduchú simuláciu meteorov. Toto nastavenie určuje, aké množstvo meteorov sa objaví. Meteory sú však viditeľné iba v prípade, že rýchlosť plynutia času je 1 a nemusia byť viditeľné v určitých denných hodinách. Meteorické dažde v súčasnosti nie sú simulované.

4.4.2 Záložka značenia

Záložka značenia v okne pohľadu**??** nastavuje nasledujúce vlasnosti:

Nebeská_obloha Táto skupina možností umožňuje zakresliť rôzne mriežky a čiary v hlavnom pohľade.

Konštelácie Tieto ovládacie prvky vám umožňujú zapnúť a vypnúť čiary, názvy, ilustrácie a ohraničenia konštelácií a nastaviť ich jas.

Projekcia Výber položky v tomto zozname nastavuje spôsob, akým Stellarium zobrazuje oblohu. Možnosti sú:

valec Celý názov tejto projekcie je *cylindrical equidistant projection*. Maximálne zorné pole v tomto prípade je 233°.

equal area Celý názov pre túto projekčnú metódu je *Lambert azimuthal equal-area projection*. Maximálne zorné pole je 360°.

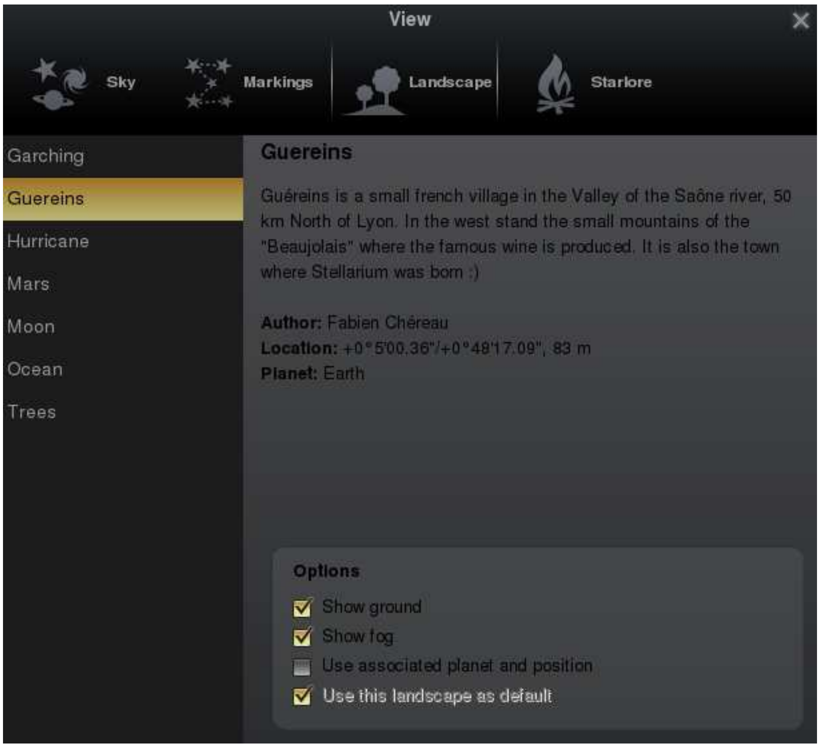
rybie_oko Stellarium vykresľuje oblohu pomocou azimutálnej rovnomernej projekcie. Pri projekcii rybie oko, rovné čiary sa stanú krivkami, keď sa javia vo veľkej uhlovej vzdialenosti od centra zorného poľa (ako skreslenie viditeľné pri veľmi širokouhlých šošovkách vo kamerách). Toto je tým zreteľnejšie, čím viac užívateľ odďaľuje. Maximálne zorné pole je 180°.

mercator Táto projekcia zachováva uhly medzi objektmi a jeho mierku rovnakú vo všetkých smeroch. Maximálne zorné pole v tomto móde je 233°.

ortografická Ortografická projekcia súvisí s perspektívnou, ale bod perspektívy je nastavený na nekonečnú vzdialenosť. Maximálne zorné pole je 180°.

perspektíva Perspektívna projekcia zobrazuje horizont ako rovnú čiaru. Maximálne zorné pole je 150°. Matematický názov pre túto metódu projekcie je *gnomonická projekcia*.

stereografická Tento mód je podobný rybiemu oku. Maximálne zorné pole je235°.



4.4.3 Záložka terénu

Záložka terénu v okne pohľadu nastavuje grafiku terénu okolitej krajiny. Toto zmeníte výberom terénu zo zoznamu v ľavej časti okna. Popis terénu bude zobrazený napravo.

Zatiaľ čo terén môže obsahovať informácie o tom, kde bola fotografia urobená (planéta, zem. šírka, dĺžka a nadmorská výška), táto lokalita nemusí korešpondovať s lokalitou nastavenou v okne polohy, i keď sa dá Stellarium nastaviť tak, aby zmena polohy upravovala automaticky aj terén.

Ovládacie prvky v pravej dolnej časti okna fungujú nasledovne:

Zobraziť_terén Zapína a vypína zobrazenie terénu (rovnaké ako tlačidlo na hlavnej lište).

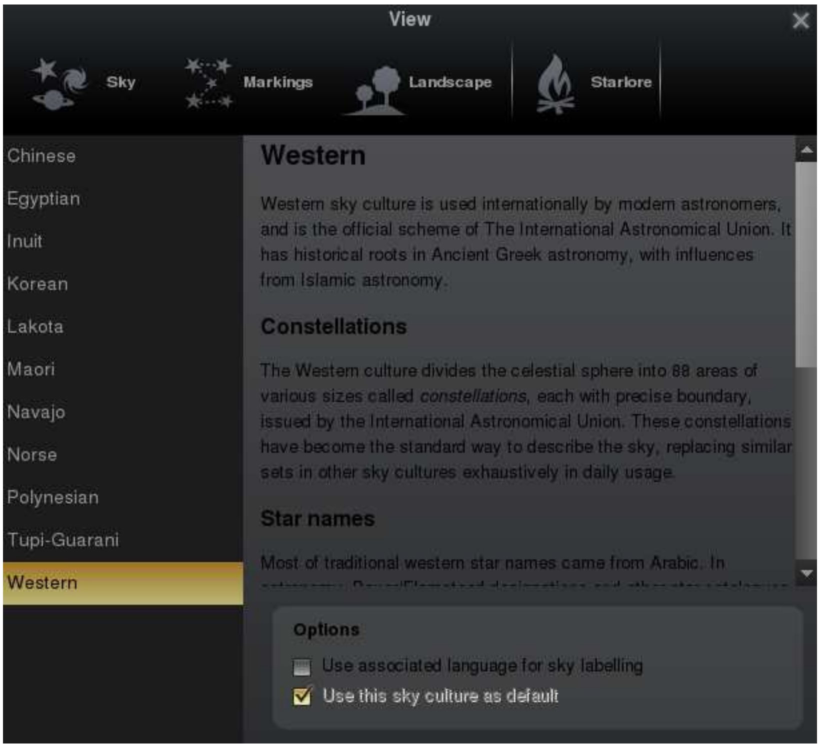
Zobraziť_opar Zapína a vypína zobrazenie oparu pozdĺž horizontu.

Použiť_príslušnú_planétu_a_pozíciu Ak je táto možnosť aktívna, zmenou terénu sa zmení aj poloha.

Použiť_tento_terén_ako_východzí Táto možnosť uloží aktuálne nastavenie terénu do konfiguračného súboru, takže pri spustení Stellaria sa tento terén automaticky nastaví.

4.4.4 Záložka tradícií

Záložka tradícií v okne poľadu určuje, konštelácie a názvy jasných hviezd ktorej kultúry sa majú použiť v hlavnom zobrazení. Niektoré kultúry majú vlastné nákresy konštelácií (Západné a "Inuit"), ostatné nemajú.


View
Sky
Markings
Landscape
Starlore
Chinese
Egyptian
Inuit
Korean
Lakota
Maori
Navajo
Norse
Polynesian
Tupi-Guarani
Western
Western
Western sky culture is used internationally by modern astronomers, and is the official scheme of The International Astronomical Union. It has historical roots in Ancient Greek astronomy, with influences from Islamic astronomy.
Constellations
The Western culture divides the celestial sphere into 88 areas of various sizes called constellations, each with precise boundary, issued by the International Astronomical Union. These constellations have become the standard way to describe the sky, replacing similar sets in other sky cultures exhaustively in daily usage.
Star names
Most of traditional western star names came from Arabic. In
Options
Use associated language for sky labelling
Use this sky culture as default

Chapter 5

Advanced Use

5.1 Files and Directories

Stellarium has many data files containing such things as star catalogue data, nebula images, button icons, font files and configuration files. When Stellarium looks for a file, it looks in two places. First, it looks in the *user directory* for the account which is running Stellarium. If the file is not found there, Stellarium looks in the *installation directory*[1]. Thus it is possible for Stellarium to be installed as an administrative user and yet have a writable configuration file for non-administrative users. Another benefit of this method is on multi-user systems: Stellarium can be installed by the administrator, and different users can maintain their own configuration and other files in their personal user accounts.

In addition to the main search path, Stellarium saves some files in other locations, for example screens shots and recorded scripts.

The locations of the user directory, installation directory, *screenshot save directory* and *script save directory* vary according to the operating system and installation options used. The following sections describe the locations for various operating systems.

5.1.1 Windows

installation directory By default this is `C:\Program Files\Stellarium\`, although this can be adjusted during the installation process.

user directory This is the `Stellarium` sub-folder in the Application Data folder for the user account which is used to run Stellarium. Depending on the version of Windows and its configuration, this could be any of the following (each of these is tried, if it fails, the next in the list if tried).

```
%APPDATA%\Stellarium\
%USERPROFILE%\Stellarium\
%HOMEDRIVE%\%HOMEPATH%\Stellarium\
%HOME%\Stellarium\
Stellarium's installation directory
```

Thus, on a typical Windows XP system with user "Bob Dobbs", the user directory will be:

```
C:\Documents and Settings\Bob Dobbs\Application Data\Stellarium\
```

[1] The installation directory was referred to as the *config root directory* in previous versions of this guide

Stellarium version 0.9.0 did use the `%APPDATA%\Stellarium` folder. Thus if a `config.ini` file exists in the `%USERPROFILE%\Stellarium\` directory, that will be used in preference to the `%APPDATA%\Stellarium\` directory. This is to prevent users of version 0.9.0 from losing their settings when they upgrade.

screenshot save directory Screenshots will be saved to the Desktop, although this can be changed with a command line option (see section 5.3)[2].

5.1.2 MacOS X

installation directory This is found inside the application bundle, `Stellarium.app`. See the Inside Application Bundles for more information.

user directory This is the `Library/Preferences/Stellarium/` sub-directory of the users home directory.

screenshot save directory Screenshots are saved to the users Desktop.

5.1.3 Linux

installation directory This is in the `share/stellarium` sub-directory of the installation prefix, i.e. usually `/usr/share/stellarium` or `/usr/local/share/stellarium/`.

user directory This is the `.stellarium` sub-directory of users home directory, i.e. `~/.stellarium/`.

screenshot save directory Screenshots are saved to the users home directory.

5.1.4 Directory Structure

Within the *installation directory* and *user directory* (defined in section 5.1), files are arranged in the following sub-directories.

landscapes/ contains data files and textures used for Stellarium's various landscapes. Each landscape has it's own sub-directory. The name of this sub-directory is called the *landscape ID*, which is used to specify the default landscape in the main configuration file.

skycultures/ contains constellations, common star names and constellation artwork for Stellarium's many sky cultures. Each culture has it's own sub-directory in the skycultures directory.

nebulae/ contains data and image files for nebula textures. In future Stellarium will be able to support multiple sets of nebula images and switch between them at runtime. This feature is not implemented for version 0.9.1, although the directory structure is in place - each set of nebula textures has it's own sub-directory in the `nebulae` directory.

stars/ contains Stellarium's star catalogues. In future Stellarium will be able to support multiple star catalogues and switch between them at runtime. This feature is not implemented for version 0.10.0, although the directory structure is in place - each star catalogue has it's own sub-directory in the `stars` directory.

data/ contains miscellaneous data files including fonts, solar system data, city locations etc.

[2] Windows *Vista* users who do not run Stellarium with administrator priviliges should adjust the shortcut in the start menu to specify a different directory for screenshots as the Desktop directory is not writable for normal progams. The next release of Stellarium will include a GUI option to specify the screenshot directory.

textures/ contains miscellaneous texture files, such as the graphics for the toolbar buttons, planet texture maps etc.

If any file exists in both the installation directory and user directory, the version in the user directory will be used. Thus it is possible to override settings which are part of the main Stellarium installation by copying the relevant file to the user area and modifying it there.

It is also possible to add new landscapes by creating the relevant files and directories within the user directory, leaving the installation directory unchanged. In this manner different users on a multi-user system can customise Stellarium without affecting the other users.

5.2 The Main Configuration File

The main configuration file is read each time Stellarium starts up, and settings such as the observer's location and display preferences are taken from it. Ideally this mechanism should be totally transparent to the user - anything that is configurable should be configured "in" the program GUI. However, at time of writing Stellarium isn't quite complete in this respect, despite improvements in version 0.10.0. Some settings can only be changed by directly editing the configuration file. This section describes some of the settings a user may wish to modify in this way, and how to do it.

If the configuration file does not exist in the *user directory* when Stellarium is started (e.g. the first time the user starts the program), one will be created with default values for all settings (refer to section 5.1 for the location of the user directory on your operating system). The name of the configuration file is `config.ini`[3].

The configuration file is a regular text file, so all you need to edit it is a text editor like *Notepad* on Windows, *Text Edit* on the Mac, or *nano/vi/gedit* etc. on Linux.

The following sub-sections contain details on how to make commonly used modifications to the configuration file. A complete list of configuration file values may be found in appendix A.

5.3 Command Line Options

Stellarium's behaviour can be modified by providing parameters to the program when it is run, via the command line. See table **??** for a full list.

5.3.1 Examples

- To start Stellarium using the configuration file, `configuration_one.ini` situated in the user directory (use either of these):

```
stellarium --config-file=configuration_one.ini
stellarium -c configuration_one.ini
```

- To list the available landscapes, and then to start using the landscape with the ID, "ocean"

```
stellarium --list-landscapes
stellarium --landscape=ocean
```

[3] It is possible to specify a different name for the main configuration file using the `--config-file` command line option. See section 5.3 for details.

Option	*Option Parameter*	*Description*
--help or -h	[none]	Print a quick command line help message and exit.
--version or -v	[none]	Print the program name and version information, and exit.
--config-file or -c	config file name	Specify the configuration file name. The default value is config.ini. The parameter can be a full path (which will be used verbatim) or a partial path. Partial paths will be searched for inside the regular search paths unless they start with a ".", which may be used to explicitly specify a file in the current directory or similar. For example, using the option -c my_config.ini would resolve to the file <user directory>/my_config.ini whereas -c ./my_config.ini can be used to explicitly say the file my_config.ini in the current working directory.
--restore-defaults	[none]	If this option is specified Stellarium will start with the default configuration. Note: The old configuration file will be overwritten.
--user-dir	path	Specify the user data directory.
--screenshot-dir	path	Specify the directory to which screenshots will be saved.
--full-screen	yes or no	Over-rides the full screen setting in the config file.
--home-planet	planet	Specify observer planet (English name).
--altitude	altitude	Specify observer altitude in meters.
--longitude	longitude	Specify latitude, e.g. +53d58\'16.65\"
--latitude	latitude	Specify longitude, e.g. -1d4\'27.48\"
--list-landscapes	[none]	Print a list of available landscape IDs.
--landscape	landscape ID	Start using landscape whose ID matches the passed parameter (dir name for landscape).
--sky-date	date	The initial date in yyyymmdd format.
--sky-time	time	The initial time in hh:mm:ss format
--fov	angle	The initial field of view in degrees.
--projection-type	ptype	The initial projection type (e.g. perspective).

5.4 Getting Extra Star Data

Stellarium is packaged with over 600 thousand stars in the normal program download, but much larger star catalogues are available for from the sourceforge download site. To use these catalogues, download the files and save them in the `stars/default/` sub-directory of either the Installation Directory or the User Directory (see section 5.1).

There are five extra catalogue files available.

NOTE: You should have at least 512 MiB of RAM to load files `stars_4_2v0_0.cat` *to* `stars_4_2v0_0.cat`*, and at least 1 GiB RAM to load the largest file (*`stars_8_2v0_0.cat`*).*

See section E for details of the contents of these files.

5.5 Scripting

Scripting is not available in version 0.10.0 - it was one of the features which were not yet completed since the major re-working of the code. The goal is to implement a new scripting engine in the next release, which will be a lot more powerful than the scripting engine which was a feature of previous releases.

5.6 Visual Effects

5.6.1 Light Pollution

Stellarium can simulate light pollution, which is controlled from the light pollution section of the Sky tab of the View window. Light pollution levels are set using an numerical value between 1 and 9 which corresponds to the *Bortle Dark Sky Scale*.

5.7 Customising Landscapes

It is possible to create your own landscapes for Stellarium. There are three types of landscape:

Single Fish-eye Method Using a fish-eye panorama image.

Single Spherical Method Using a spherical panorama image.

Multiple Image Method (also called "old style" landscapes) Using a series of images split from a 360° "strip" panorama image + a ground image.

Each landscape has it's own sub-directory in `<user directory>/landscapes` or `<installation directory>/landscapes`. The name of the sub-directory is called the *landscape ID*. The sub-directory must contain a file called `landscape.ini` which describes the landscape type, texture filenames and other data. Texture files for a landscape should by put in the same directory as the `landscape.ini` file, although if they are not found there they will be searched for in the `.../textures` directory, allowing shared files for common textures such as the fog texture.

For example, the *Moon* landscape that is provided with Stellarium has the following files:

```
.../landscapes/moon/landscape.ini
.../landscapes/moon/apollo17.png
```

The `landscsape.ini` file must contain a section called `[landscape]`, which contains the details necessary to render the landscape (which vary, depending on the type of the landscape).

Level	Title	Colour	Limiting magnitude (eye)	Description
1	Excellent dark sky site	black	7.6 – 8.0	Zodiacal light, gegenschein, zodiacal band visible; M33 direct vision naked-eye object; Scorpius and Sagittarius regions of the Milky Way cast obvious shadows on the ground; Airglow is readily visible; Jupiter and Venus affect dark adaptation; surroundings basically invisible.
2	Typical truly dark site	grey	7.1 – 7.5	Airglow weakly visible near horizon; M33 easily seen with naked eye; highly structured Summer Milky Way; distinctly yellowish zodiacal light bright enough to cast shadows at dusk and dawn; clouds only visible as dark holes; surroundings still only barely visible silhouetted against the sky; many Messier globular clusters still distinct naked-eye objects.
3	Rural sky	blue	6.6 – 7.0	Some light pollution evident at the horizon; clouds illuminated near horizon, dark overhead; Milky Way still appears complex; M15, M4, M5, M22 distinct naked-eye objects; M33 easily visible with averted vision; zodiacal light striking in spring and autumn, color still visible; nearer surroundings vaguely visible.
4	Rural/suburban transition	green/yellow	6.1 – 6.5	Light pollution domes visible in various directions over the horizon; zodiacal light is still visible, but not even halfway extending to the zenith at dusk or dawn; Milky Way above the horizon still impressive, but lacks most of the finer details; M33 a difficult averted vision object, only visible when higher than 55°; clouds illuminated in the directions of the light sources, but still dark overhead; surroundings clearly visible, even at a distance.
5	Suburban sky	orange	5.6 – 6.0	Only hints of zodiacal light are seen on the best nights in autumn and spring; Milky Way is very weak or invisible near the horizon and looks washed out overhead; light sources visible in most, if not all, directions; clouds are noticeably brighter than the sky.
6	Bright suburban sky	red	5.1 – 5.5	Zodiacal light is invisible; Milky Way only visible near the zenith; sky within 35° from the horizon glows grayish white; clouds anywhere in the sky appear fairly bright; surroundings easily visible; M33 is impossible to see without at least binoculars, M31 is modestly apparent to the unaided eye.
7	Suburban/urban transition	red	5.0 at best	Entire sky has a grayish-white hue; strong light sources evident in all directions; Milky Way invisible; M31 and M44 may be glimpsed with the naked eye, but are very indistinct; clouds are brightly lit; even in moderate-sized telescopes the brightest Messier objects are only ghosts of their true selves.
8	City sky	white	4.5 at best	Sky glows white or orange–you can easily read; M31 and M44 are barely glimpsed by an experienced observer on good nights; even with telescope, only bright Messier objects can be detected; stars forming familiar constellation patterns may be weak or completely invisible.
9	Inner City sky	white	4.0 at best	Sky is brilliantly lit with many stars forming constellations invisible and many weaker constellations invisible; aside from Pleiades, no Messier object is visible to the naked eye; only objects to provide fairly pleasant views are the Moon, the Planets and a few of the brightest star clusters.

Table 5.3: Bortle Dark Sky Scale (from Wikipedia)

There is also an optional `[location]` section which is used to tell Stellarium where the landscape is in the solar system. If the `[location]` section exists, Stellarium can automatically adjust the location of the observer to match the landscape.

5.7.1 Single Fish-eye Method

The *Trees* landscape that is provided with Stellarium is an example of the single fish-eye method, and provides a good illustration. The centre of the image is the spot directly above the observer (the zenith). The point below the observer (the nadir) becomes a circle that just touches the edges of the image. The remaining areas of the image (the rounded corners) are not used.

The image file should be saved in PNG format with alpha transparency. Wherever the image is transparent is where Stellarium will render the sky.

The `landscape.ini` file for a fish-eye type landscape looks like this (this example if for the Trees landscape which comes with Stellarium):

```
[landscape]
name = Trees
type = fisheye
maptex = trees_512.png
texturefov = 210
```

Where:

name is what appears in the landscape tab of the configuration window.

type identifies the method used for this landscape. “fisheye” in this case.

maptex is the name of the image file for this landscape.

texturefov is the field of view that the image covers in degrees.

5.7.2 Single Panorama Method

This method uses a more usual type of panorama - the kind which is produced directly from software such as *autostitich*. The panorama file should be copied into the `<config root>/landscapes/<landscape_id>` directory, and a `landscape.ini` file created. The *Moon* landscape which comes with Stellarium provides a good example of the contents of a `landscape.ini` file for a spherical type landscape:

```
[landscape]
name = Moon
type = spherical
maptex = apollo17.png
```

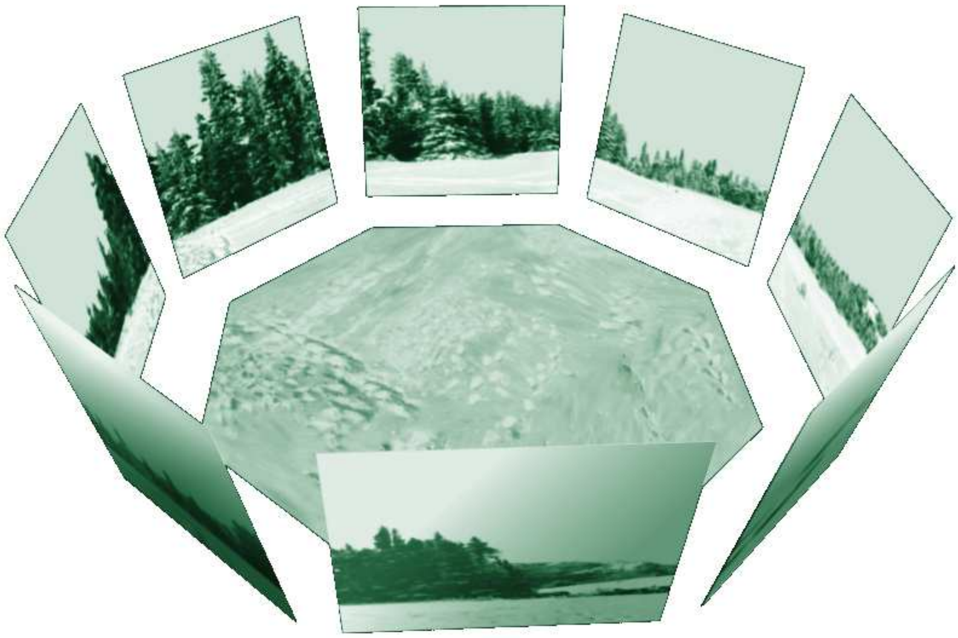
Where:

name is what appears in the landscape tab of the configuration window.

type identifies the method used for this landscape. “spherical” in this case.

maptex is the name of the image file for this landscape.

Note that the name of the section, in this case `[moon]` must be the landscape ID (i.e. the same as the name of the directory where the `landscape.ini` file exists).



5.7.3 Multiple Image Method

The multiple image method works by having a 360 panorama of the horizon split into a number of smaller “side textures”, and a separate “ground texture”. This has the advantage over the single image method that the detail level of the horizon can be increased further without ending up with a single very large image file. The ground texture can be a lower resolution than the panorama images. Memory usage may be more efficient because there are no unused texture parts like the corners of the texture file in the fish-eye method.

On the negative side, it is more difficult to create this type of landscape - merging the ground texture with the side textures can prove tricky. The contents of the `landscape.ini` file for this landscape type is also somewhat more complicated than for other landscape types. Here is the `landscape.ini` file which describes the Guereins landscape:

```
[landscape]
name = Guereins
type = old_style
nbsidetex = 8
tex0 = guereins4.png
tex1 = guereins5.png
tex2 = guereins6.png
tex3 = guereins7.png
tex4 = guereins8.png
tex5 = guereins1.png
tex6 = guereins2.png
tex7 = guereins3.png
nbside = 8
side0 = tex0:0:0.005:1:1
side1 = tex1:0:0.005:1:1
side2 = tex2:0:0.005:1:1
side3 = tex3:0:0.005:1:1
side4 = tex4:0:0.005:1:1
```

```
side5 = tex5:0:0.005:1:1
side6 = tex6:0:0.005:1:1
side7 = tex7:0:0.005:1:1
groundtex = guereinsb.png
ground = groundtex:0:0:1:1
fogtex = fog.png
fog = fogtex:0:0:1:1
nb_decor_repeat = 1
decor_alt_angle = 40
decor_angle_shift = -22
decor_angle_rotatez = 0
ground_angle_shift = -22
ground_angle_rotatez = 45
fog_alt_angle = 20
fog_angle_shift = -3
draw_ground_first = 1
```

Where:

name is the name that will appear in the landscape tab of the configuration window for this landscape

type should be "old_style" for the multiple image method.

nbsidetex is the number of side textures for the landscape.

tex0 ... tex<nbsidetex-1> are the side texture file names. These should exist in the `.../textures/landscapes` directory in PNG format.

nbside is the number of side textures

side0 ... side<nbside-1> are the descriptions of how the side textures should be arranged in the program. Each description contains five fields separated by colon characters (:). The first field is the ID of the texture (e.g. tex0), the remaining fields are the coordinates used to place the texture in the scene.

groundtex is the name of the ground texture file.

ground is the description of the projection of the ground texture in the scene.

fogtex is the name of the texture file for fog in this landscape.

fog is the description of the projection of the fog texture in the scene.

nb_decor_repeat is the number of times to repeat the side textures in the 360 panorama.

decor_alt_angle is the vertical angular size of the textures (i.e. how high they go into the sky).

decor_angle_shift vertical angular offset of the scenery textures, at which height are the side textures placed.

decor_angle_rotatez angular rotation of the scenery around the vertical axis. This is handy for rotating the landscape so North is in the correct direction.

ground_angle_shift vertical angular offset of the ground texture, at which height the ground texture is placed.

ground_angle_rotatez angular rotation of the ground texture around the vertical axis. When the sides are rotated, the ground texture may need to me rotated as well to match up with the sides.

fog_alt_angle vertical angular size of the fog texture - how fog looks.

fog_angle_shift vertical angular offset of the fog texture - at what height is it drawn.

draw_ground_first if 1 the ground is drawn in front of the scenery, i.e. the side textures will overlap over the ground texture.

Note that the name of the section, in this case `[guereins]` must be the landscape ID (i.e. the same as the name of the directory where the `landscape.ini` file exists).

A step-by-step account of the creation of a custom landscape has been contributed by Barry Gerdes. See Appendix F.

5.7.4 `landscape.ini [location]` section

An example location section:

```
[location]
planet = Earth
latitude = +48d10'9.707"
longitude = +11d36'32.508"
altitude = 83
```

Where:

planet Is the English name of the solar system body for the landscape.

latitude Is the latitude of site of the landscape in degrees, minutes and seconds. Positive values represent North of the equator, negative values South of the equator.

longitude Is the longitude of site of the landscape. Positive values represent East of the Greenwich Meridian on Earth (or equivalent on other bodies), Negative values represent Western longitude.

altitude Is the altitude of the site of the landscape in meters.

5.8 Adding Nebulae Images

Extended objects are those which are external to the solar system, and are not point-sources like stars. Extended objects include galaxies, planetary nebulae and star clusters. These objects may or may not have images associated with them. Stellarium comes with a catalogue of about 13,000 extended objects, with images of over 100.

To add a new extended object, add an entry in the `.../nebulae/default/ngc2000.dat` file with the details of the object (where ... is either the installation directory or the user directory). See section 5.8.1 for details of the file format.

If the object has a name (not just a catalogue number), you should add one or more records to the `.../nebulae/default/ngc2000names.dat` file. See section 5.8.2 for details of the file format.

If you wish to associate a texture (image) with the object, you must also add a record to the `.../nebulae/default/nebula_textures.fab` file. See section 5.8.3 for details of the file format.

Nebula images should have dimensions which are integer powers of two, i.e. 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024 ... pixels along each side. If this requirement is not met, your textures may not be visible, or graphics performance may be seriously impacted. PNG or JPG formats are both supported.

5.8.1 Modifying `ngc2000.dat`

Each deep sky image has one line in the `ngc2000.dat` file in the `.../nebulae/default/` directory (where ... is either the installation directory or the user directory). The file is a plain ASCII file, and may be edited with a normal text editor. Each line contains one record, each record consisting of the following fields:

Offset	*Length*	*Type*	*Description*
0	1	%c	Describes the catalogue type. I = Index Catalogue, anything else means NGC
1	6	%d	Catalogue number

8	3	%3s	Sets nType.
			Possible values:
			`'Gx ' NEB_OC`
			`'OC ' NEB_GC`
			`'Gb ' NEB_N`
			`'Nb ' NEB_PN`
			`'Pl '`
			`'   '`
			`' - '`
			`' * '`
			`'D* '`
			`'***'`
			`'C+N' NEB_CN`
			`' ? '  NEB_UNKNOWN`

12	9	%d %f	Right ascension hour; right ascension minute
21	1	%c	Declination degree sign
22	7	%d %f	Declination degree; Declination minute
40	7	%f	Angular size
47	6	%f	Magnitude

5.8.2 Modifying `ngc2000names.dat`

Each line in the `ngc2000names.dat` file contains one record. A record relates an extended object catalogue number (from `ngc2000.dat`) with a name. A single catalogue number may have more than one record in this file.

The record structure is as follows:

Offset	*Length*	*Type*	*Description*
0	35	%35s	Name (Note that messier numbers should be “M” then three spaces, then the number).
37	1	%c	
38		%d	Catalogue number
44	30?	%s	?

If an object has more than one record in the `ngc2000names.dat` file, the last record in the file will be used for the nebula label.

5.8.3 Modifying `nebula_textures.fab`

Each line in the `nebula_textures.fab` file is one record. Records are whitespace separated so there are not strictly any offsets for particular fields. Note that filenames may not contains spaces, and are case sensitive.

Table 5.7: Sky culture configuration files

Lines with the # character in the first column are considered to be comments and will be ignored. Empty lines are ignored.

The record format is as follows:

Type	*Description*
int	Catalogue number
float	Right ascension
float	Declination
float	Magnitude
float	Texture angular size
float	Texture rotation
string	Texture filename (including .png extension)
string	Credit

5.8.4 Editing Image Files

Images files should be copied to the `.../nebulae/<set>/` directory (where `<set>` is the name of the nebula texture set to be modified which is usually `default`. Images should be in PNG or JPEG format. Images should have an aspect ratio of 1 (i.e. it should be square), and should have a width & height of 2^n pixels, where n is a positive integer (i.e. 2, 4, 8, 16, 32, 64, 128, 256, 512, and so on).

Black is interpretted as being 100% transparent. Ensure that the background of the image is totally black (i.e. has RGB values 0, 0, 0), and not just *nearly black* since this can cause an ugly square around the object.

There is a lot of software which may be used to create / modify PNG and JPEG images. The author recommends the GNU Image Manipulation Program (GIMP), since it is more than up to the job, and is free software in the same spirit as Stellarium itself.

5.9 Sky Cultures

Sky cultures are defined in the `skycultures/` directory which may be found in the *installation directory* and/or *user directory*. Inside is one sub-directory per sky culture, each of these containing settings and image files as described in table 5.7. Section names should be unique within the `ssystem.ini` file.

File	Purpose
`constellation_names.eng.fab`	This file contains a list of names for each constellation (from the three latter abbreviation of the constellation).

`constellationsart.fab`	This file contains the details of pictorial representations of the constellations. fields are: 1. Constellation abbreviation 2. image filename. This will be appended to `.../skycultures/<culturename>/`. Should include the `.png` extension. Note - this is case sensitive. 3. Star 1 x position in image (pixel) 4. Star 1 y position in image (pixel) 5. Star 1 HP catalogue number 6. Star 2 x position in image (pixel) 7. Star 2 y position in image (pixel) 8. Star 2 HP catalogue number 9. Star 3 x position in image (pixel) 10. Star 3 y position in image (pixel) 11. Star 3 HP catalogue number
`constellationship.fab`	Describes the lines for the constellations. The fields are: 1. Constellation abbreviation 2. Number of lines After this are pairs of HP catalogue numbers which the lines are drawn between.
`info.ini`	Contains the name for this sky culture as it will appear in the configuration dialog's language tab.
`star_names.fab`	Contains a list of HP catalogue numbers and common names for those stars.

5.10 Adding Planetary Bodies

Planetary bodies include planets, dwarf planets, moons, comets and asteroids. The orbits and physical characteristics of these bodies are described in the `.../data/ssystem.ini` file.

The file format follows `.ini` file conventions. Each section in the file represents the data for one planetary body. Each section has values as described in table **??**.

Orbital calculations for the major planets is handled by sophisticated custom algorithms, and are accurate for a comparatively long time. For asteroids and comets the calculations are not as accurate, and the data in ssystem.ini for these bodies should be updated periodically (every year or two).

At present this must be done manually by editing the ssystem.ini file.

An example entry might look like this:

```
[ceres]
name = Ceres
```

Name	*Format*	*Description*
name	string	English name of body, case-sensitive
parent	string	English name of parent body (the body which this body orbits, e.g. in the case of our Moon, the parent body is Earth)
radius	float	Radius of body in kilometers
halo	boolean	If true, the body will have a halo displayed round it when it is bright enough
color	r,g,b	Colour of object (when rendered as a point). Each of r,g,b is a floating point number between 0 and 1.
tex_map	string	File name of a PNG or JPEG texture file to be applied to the object. Texture file is searched for in the `.../textures` directory
tex_halo	string	File name of a PNG or JPEG texture file to be used as the halo image if the halo option is set to true
tex_big_halo	string	File name of a PNG or JPEG texture file to be used as the "big halo" image
big_halo_size	float	The angular size of the big halo texture. Typical values range between 10 and 200.
coord_func	string	Select the method of calculating the orbit. Possible values are: *ell_orbit*, *comet_orbit*, *<planet>_special* (specific calculations for major bodies).
lighting	boolean	Turn on or off lighting effects
albedo	float	Specify the albedo of the body
rot_periode	float	Specify the rotational period of the body in hours
rot_obliquity	float	Angle between rotational axis and perpendicular to orbital plane in degrees
rot_equator_ascending_node	float	Rotational parameter
sidereal_period	float	Rotational period in days
orbit_Period	float	Time for one full orbit in days
orbit_SemiMajorAxis	float	Keplarian orbital element
orbit_Eccentricity	float	Keplarian orbital element
orbit_Inclination	float	Keplarian orbital element
orbit_AscendingNode	float	Keplarian orbital element
orbit_LongOfPericenter	float	Orbital element used in ell_orbit calculations
orbit_MeanLongitude	float	Orbital element used in ell_orbit calculations
ascending	float	Orbital element used in ell_orbit calculations
hidden	boolean	Display planet as seen from other bodies, or not
orbit_TimeAtPericenter	float	Object parameter used in comet_orbit calculations
orbit_PericenterDistance	float	Object parameter used in comet_orbit calculations
orbit_MeanAnomoly	float	Object parameter used in comet_orbit calculations
orbit_ArgOf Pericenter	float	Object parameter used in comet_orbit calculations

```
parent = Sun
radius = 470
oblateness = 0.0
albedo = 0.113
halo = true
color = 1.0,1.0,1.0
tex_halo = star16x16.png
coord_func = comet_orbit
#orbit_TimeAtPericenter = 2453194.01564059
#orbit_PericenterDistance = 2.54413510097202
orbit_Epoch = 2453800.5
orbit_MeanAnomaly = 129.98342
orbit_SemiMajorAxis = 2.7653949
orbit_Eccentricity = 0.0800102
orbit_ArgOfPericenter = 73.23162
orbit_AscendingNode = 80.40970
orbit_Inclination = 10.58687
lighting = true
sidereal_period = 1680.15
```

5.11 Other Configuration Files

In addition to the files discussed in the previous sections, Stellarium uses various other data files. Many of these files may be edited easily to change Stellarium's behaviour[4]. See table **??**.

[4] Not all files in the `.../data` directory are listed here - only the ones which the advanced user is most likely to want to modify.

File	*Purpose*
`.../data/cities.fab`	Each line is one record which describes a city which will appear on the map in the location tab of the configuration dialog. Each record is TAB separated with the following fields: 1. City name 2. State / Province or <> for none (spaces replaced with underscores) 3. Country 4. Latitude 5. Longitude 6. Altitude 7. Time zone 8. Show at zoom-level
`.../data/constellations_boundaries.dat`	This file provides data necessary for Stellarium to draw the boundaries of he constellations.
`.../stars/*/name.fab`	This file defines the Flamsteed designation for a star (see section H.2.4.2). Each line of the file contains one record of two fields, separated by the pipe character (`|`). The first field is the Hipparcos catalogue number of the star, the second is the Flamsteed designation, e.g: `72370|`α`_Aps`
`.../data/zone.tab`	Time zone information.

5.12 Taking Screenshots

You can save what is on the screen to a file by pressing `CTRL-s`. Screenshots are taken in `.bmp` format, and have filenames something like this: `stellarium-000.bmp`, `stellariuim-001.bmp` (the number increments to prevent over-writing existing files).

Stellarium creates screenshots in different directories depending in your system type, see section 5.1.

5.13 Telescope Control

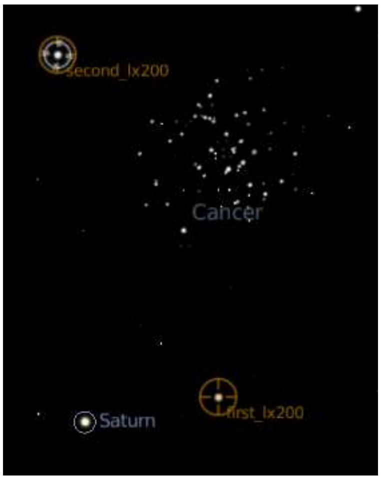
Stellarium has a simple control mechanism for motorised telescope mounts. The user selects an object (i.e. by clicking on something - a planet, a star etc.) and presses the *telescope go-to* key (see section **??**) and the telescope will be guided to the object.

Multiple telescopes may be controlled simultaneously.

WARNING: Stellarium will not prevent your telescope from being pointed at the Sun. It is up to you to ensure proper filtering and safety measures are applied!

5.13.1 Telescope Servers

Note that telescope control is not available in version 0.10.0 of Stellarium. This feature is still being re-worked and will make a re-appearance in a future release.


second_lx200
Cancer
Saturn
first_lx200

Appendix A

Configuration file

Section	*ID*	*Type*	*Description*
[video]	fullscreen	boolean	if *true*, Stellarium will start up in full-screen mode. If *false*, Stellarium will start in windowed mode
[video]	screen_w	integer	sets the display width (value in pixels, e.g. *1024*)
[video]	screen_h	integer	sets the display height (value in pixels, e.g. *768*)
[video]	bbp_mode	integer	Sets the number of bits per pixel. Values: *16(?), 24(?), 32*
[video]	horizontal_offset	integer	view-port horizontal offset
[video]	vertical_offset	integer	view-port vertical offset
[video]	distorter	string	This is used when the spheric mirror display mode is activated. Values include *none* and *fisheye_to_spheric_mirror*
[video]	minimum_fps	integer	sets the minimum number of frames per second to display at.
[video]	maximum_fps	integer	sets the maximum number of frames per second to display at. This is useful to reduce power consumption in laptops.
[projection]	type	string	sets projection mode. Values: *perspective, fisheye, stereographic, fisheye_to_spheric_mirror*
[projection]	viewport	string	how the view-port looks. Values: *maximized, disk*
[spheric_mirror]	distorter_max_fov	float	Set the maximum field of view for the spheric mirror distorter in degrees. Typical value, *180*
[spheric_mirror]	flag_use_ext_framebuffer_object	boolean	Some video hardware incorrectly claims to support some GL extension, GL_FRAMEBUFFER_EXT. If, when using the spheric mirror distorter the frame rate drops to a very low value (e.g. 0.1 FPS), set this parameter to false to tell Stellarium ignore the claim of the video driver that it can use this extension
[spheric_mirror]	flip_horz	boolean	Flip the projection horizontally

Section	*ID*	*Type*	*Description*
[spheric_mirror]	flip_vert	boolean	Flip the projection vertically
[spheric_mirror]	projector_gamma	float	This parameter controls the properties of the spheric mirror projection mode
[spheric_mirror]	projector_position_x	float	This parameter controls the properties of the spheric mirror projection mode
[spheric_mirror]	projector_position_y	float	This parameter controls the properties of the spheric mirror projection mode
[spheric_mirror]	projector_position_z	float	This parameter controls the properties of the spheric mirror projection mode
[spheric_mirror]	mirror_position_x	float	This parameter controls the properties of the spheric mirror projection mode
[spheric_mirror]	mirror_position_y	float	This parameter controls the properties of the spheric mirror projection mode
[spheric_mirror]	mirror_position_z	float	This parameter controls the properties of the spheric mirror projection mode
[spheric_mirror]	mirror_radius	float	This parameter controls the properties of the spheric mirror projection mode
[spheric_mirror]	dome_radius	float	This parameter controls the properties of the spheric mirror projection mode
[spheric_mirror]	zenith_y	float	This parameter controls the properties of the spheric mirror projection mode
[spheric_mirror]	scaling_factor	float	This parameter controls the properties of the spheric mirror projection mode
[localization]	sky_culture	string	sets the sky culture to use. Valid values are defined in the second column of `data/skycultures.fab`. Values: *western, polynesian, egyptian, chinese, lakota, navajo, inuit, korean, norse, tupi.* The sky culture affects the constellations
[localization]	sky_locale	string	Sets language used for names of objects in the sky (e.g. planets). The value is a short locale code, e.g. *en, de, en_GB*
[localization]	app_locale	string	Sets language used for Stellarium's user interface. The value is a short locale code, e.g. *en, de, en_GB*
[stars]	star_scale	float	multiplies the size of the stars. Typical value: *1.1*
[stars]	star_mag_scale	float	multiplies the magnitude of the stars (higher values mean stars appear brighter). Typical value: *1.3*
[stars]	star_twinkle_amount	float	sets the amount of twinkling. Typical value: *0.3*
[stars]	max_mag_star_name	float	sets the magnitude of the stars whose labels will be shown
[stars]	flag_star_twinkle	bool	set to *false* to turn star twinkling off, *true* to allow twinkling.
[stars]	flag_point_star	bool	set to *false* to draw stars at a size that corresponds to their brightness. When set to *true* all stars are drawn at single pixel size
[stars]	mag_converter_mag_shift	float	sets the global limiting magnitude, independent of the current field of view

Section	*ID*	*Type*	*Description*
[stars]	mag_converter_max_scaled_60deg_mag	float	sets the limiting magnitude for field of view = 60 degrees
[stars]	mag_converter_max_fov	float	sets the maximum field of view for which the magnitude conversion routine is used
[stars]	mag_converter_min_fov	float	sets the maximum field of view for which the magnitude conversion routine is used
[gui]	flag_menu	bool	set to *false* to hide the menu
[gui]	flag_help	bool	set to *true* to show help on start-up
[gui]	flag_infos	bool	set to *true* to show info on start-up
[gui]	flag_show_topbar	bool	set to *true* to show the info bar at top of the screen
[gui]	flag_show_time	bool	set to *false* to hide time
[gui]	flag_show_date	bool	set to *false* to hide date
[gui]	flag_show_appname	bool	set to *true* to show the application name in the top bar
[gui]	flag_show_selected_object_info	bool	set to *false* if you don't want info about the selected object
[gui]	base_font_size	int(?)	sets the font size. Typical value: *15*
[gui]	base_font_name	string	Selects the font, e.g. *DejaVuSans.ttf*
[gui]	flag_show_fps	bool	set to *false* if you don't want to see at how many frames per second Stellarium is rendering
[gui]	flag_show_fov	bool	set to *false* if you don't want to see how many degrees your field of view is
[gui]	flag_show_script_bar	bool	set to *true* if you want to have access to the script bar
[gui]	mouse_cursor_timeout	float	set to 0 if you want to keep the mouse cursor visible at all times. non-0 values mean the cursor will be hidden after that many seconds of inactivity
[gui]	flag_script_allow_ui	bool	when set to *false* the normal movement controls will be disabled when a script is playing *true* enables them
[gui]	flag_show_flip_buttons	bool	enables/disables display of the image flipping buttons in the main toolbar (see section **??**)
[gui]	day_key_mode	string	Specifies the amount of time which is added and subtracted when the *[ ]* - and = keys are pressed - calendar days, or sidereal days. This option only makes sense for Digitalis planetariums. Values: *calendar* or *sidereal*
[color] [night_color] [chart_color]	azimuthal_color	float R,G,B	sets the colour of the azimuthal grid in RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white
[color] [night_color] [chart_color]	gui_base_color	float R,G,B	these three numbers determine the colour of the interface in RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white
[color] [night_color] [chart_color]	gui_text_color	float R,G,B	these three numbers determine the colour of the text in RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white

Section	*ID*	*Type*	*Description*
[color] [night_color] [chart_color]	equatorial_color	float R,G,B	sets the colour of the equatorial grid in RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white
[color] [night_color] [chart_color]	equator_color	float R,G,B	sets the colour of the equatorial line in RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white
[color] [night_color] [chart_color]	ecliptic_color	float R,G,B	sets the colour of the ecliptic line in RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white
[color] [night_color] [chart_color]	meridian_color	float R,G,B	sets the colour of the meridian line in RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white
[color] [night_color] [chart_color]	const_lines_color	float R,G,B	sets the colour of the constellation lines in RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white
[color] [night_color] [chart_color]	const_names_color	float R,G,B	sets the colour of the constellation names in RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white
[color] [night_color] [chart_color]	const_boundary_color	float R,G,B	sets the colour of the constellation boundaries in RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white
[color] [night_color] [chart_color]	nebula_label_color	float R,G,B	sets the colour of the nebula labels in RGB values, where "1" is the maximum, e.g. *1.0,1.0,1.0* for white
[color] [night_color] [chart_color]	nebula_circle_color	float R,G,B	sets the colour of the circle of the nebula labels in RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white
[color] [night_color] [chart_color]	star_label_color	float R,G,B	sets the colour of the star labels in RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white
[color] [night_color] [chart_color]	star_circle_color	float R,G,B	sets the colour of the circle of the star labels in RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white
[color] [night_color] [chart_color]	cardinal_color	float R,G,B	sets the colour of the cardinal points in RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white
[color] [night_color] [chart_color]	planet_names_color	float R,G,B	sets the colour of the planet names in RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white
[color] [night_color] [chart_color]	planet_orbits_color	float R,G,B	sets the colour of the planet orbits in RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white
[color] [night_color] [chart_color]	object_trails_color	float R,G,B	sets the colour of the planet trails in RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white
[color] [night_color] [chart_color]	chart_color	float R,G,B	sets the colour of the chart in RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white
[color] [night_color] [chart_color]	telescope_circle_color	float R,G,B	sets the colour of the telescope location indicator. RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white

Section	*ID*	*Type*	*Description*
[color] [night_color] [chart_color]	telescope_label_color	float R,G,B	sets the colour of the telescope location label. RGB values, where *1* is the maximum, e.g. *1.0,1.0,1.0* for white
[tui]	flag_enable_tui_menu	bool	enables or disables the TUI menu
[tui]	flag_show_gravity_ui	bool	[color][night_color][chart_color]
[tui]	flag_show_tui_datetime	bool	set to *true* if you want to see a date and time label suited for dome projections
[tui]	flag_show_tui_short_obj_info	bool	set to *true* if you want to see object info suited for dome projections
[navigation]	preset_sky_time	float	preset sky time used by the dome version. Unit is Julian Day. Typical value: *2451514.250011573*
[navigation]	startup_time_mode	string	set the start-up time mode, can be *actual* (start with current real world time), or *Preset* (start at time defined by preset_sky_time)
[navigation]	flag_enable_zoom_keys	bool	set to *false* if you want to disable the zoom keys
[navigation]	flag_manual_zoom	bool	set to *false* for normal zoom behaviour as described in this guide. When set to *true*, the auto zoom feature only moves in a small amount and must be pressed many times
[navigation]	flag_enable_move_keys	bool	set to *false* if you want to disable the arrow keys
[navigation]	flag_enable_move_mouse	bool	doesn't seem to do very much
[navigation]	init_fov	float	initial field of view, in degrees, typical value: *60*
[navigation]	init_view_pos	floats	initial viewing direction. This is a vector with x,y,z-coordinates. x being N-S (S +ve), y being E-W (E +ve), z being up-down (up +ve). Thus to look South at the horizon use *1,0,0*. To look Northwest and up at 45°, use *-1,-1,1* and so on.
[navigation]	auto_move_duration	float	duration for the program to move to point at an object when the space bar is pressed. Typical value: *1.4*
[navigation]	mouse_zoom	float	Sets the mouse zoom amount (mouse-wheel)
[navigation]	move_speed	float	Sets the speed of movement
[navigation]	zoom_speed	float	Sets the zoom speed
[navigation]	viewing_mode	string	if set to *horizon*, the viewing mode simulate an alt/azi mount, if set to *equator*, the viewing mode simulates an equatorial mount
[navigation]	flag_manual_zoom	bool	set to *true* if you want to auto-zoom in incrementally.
[landscape]	flag_langscape	bool	set to *false* if you don't want to see the landscape at all
[landscape]	flag_fog	bool	set to *false* if you don't want to see fog on start-up
[landscape]	flag_atmosphere	bool	set to *false* if you don't want to see atmosphere on start-up

Section	*ID*	*Type*	*Description*
[landscape]	flag_landscape_sets_location	bool	set to *true* if you want Stellarium to modify the observer location when a new landscape is selected (changes planet and longitude/latitude/altitude if that data is available in the landscape.ini file)
[viewing]	atmosphere_fade_duration	float	sets the time it takes for the atmosphere to fade when de-selected
[viewing]	flag_constellation_drawing	bool	set to *true* if you want to see the constellation line drawing on start-up
[viewing]	flag_constellation_name	bool	set to *true* if you want to see the constellation names on start-up
[viewing]	flag_constellation_art	bool	set to *true* if you want to see the constellation art on start-up
[viewing]	flag_constellation_boundaries	bool	set to *true* if you want to see the constellation boundaries on start-up
[viewing]	flag_constellation_isolate_selected	bool	when set to *true*, constellation lines, boundaries and art will be limited to the constellation of the selected star, if that star is ”on” one of the constellation lines.
[viewing]	flag_constellation_pick	bool	set to *true* if you only want to see the line drawing, art and name of the selected constellation star
[viewing]	flag_azimutal_grid	bool	set to *true* if you want to see the azimuthal grid on start-up
[viewing]	flag_equatorial_grid	bool	set to *true* if you want to see the equatorial grid on start-up
[viewing]	flag_equator_line	bool	set to *true* if you want to see the equator line on start-up
[viewing]	flag_ecliptic_line	bool	set to *true* if you want to see the ecliptic line on start-up
[viewing]	flag_meridian_line	bool	set to *true* if you want to see the meridian line on start-up
[viewing]	flag_cardinal_points	bool	set to *false* if you don’t want to see the cardinal points
[viewing]	flag_gravity_labels	bool	set to *true* if you want labels to undergo gravity (top side of text points toward zenith). Useful with dome projection.
[viewing]	flag_moon_scaled	bool	change to *false* if you want to see the real moon size on start-up
[viewing]	moon_scale	float	sets the moon scale factor, to correlate to our perception of the moon’s size. Typical value: *4*
[viewing]	constellation_art_intensity	float	this number multiplies the brightness of the constellation art images. Typical value: *0.5*
[viewing]	constellation_art_fade_duration	float	sets the amount of time the constellation art takes to fade in or out, in seconds. Typical value: 1.5
[viewing]	flag_chart	bool	enable chart mode on startup
[viewing]	flag_night	bool	enable night mode on startup
[viewing]	light_pollution_luminance	float	sets the level of the light pollution simulation
[astro]	flag_stars	bool	set to *false* to hide the stars on start-up

Section	*ID*	*Type*	*Description*
[astro]	flag_star_name	bool	set to *false* to hide the star labels on start-up
[astro]	flag_planets	bool	set to *false* to hide the planet labels on start-up
[astro]	flag_planets_hints	bool	set to *false* to hide the planet hints on start-up (names and circular highlights)
[astro]	flag_planets_orbits	bool	set to *true* to show the planet orbits on start-up
[astro]	flag_light_travel_time	bool	set to *true* to improve accuracy in the movement of the planets by compensating for the time it takes for light to travel. This has an impact on performance.
[astro]	flag_object_trails	bool	turns on and off drawing of object trails (which show the movement of the planets over time)
[astro]	flag_nebula	bool	set to *false* to hide the nebulae on start-up
[astro]	flag_nebula_name	bool	set to *true* to show the nebula labels on start-up
[astro]	flag_nebula_long_name	bool	set to *true* to show the nebula long labels on start-up
[astro]	flag_nebula_display_no_texture	bool	set to *true* to suppress displaying of nebula textures
[astro]	flag_milky_way	bool	set to *false* to hide the Milky Way
[astro]	milky_way_intensity	float	sets the relative brightness with which the milky way is drawn. Typical value: 1 to 10
[astro]	max_mag_nebula_name	float	sets the magnitude of the nebulae whose name is shown. Typical value: *8*
[astro]	nebula_scale	float	sets how much to scale nebulae. a setting of *1* will display nebulae at normal size
[astro]	flag_bright_nebulae	bool	set to *true* to increase nebulae brightness to enhance viewing (less realistic)
[astro]	flag_nebula_ngc	bool	enables/disables display of all NGC objects
[astro]	flag_telescopes	bool	enables telescope control (if set to *true* stellarium will attempt to connect to a telescope server according to the values in the [telescopes] section of the config file
[astro]	flag_telescopes_name	bool	enables/disables name labels on telescope indicators
[telescopes]	(telescope number)	string	In this section the ID is the number of the telescope and the value is a colon separated list of parameters: name, protocol, hostname, port number, delay.
[telescopes]	*x*_ocular_*y*	float	Set the size of a field-of-view marker circle for telescope number *x*. More than one marker can be defined for each telescope by using values 1, 2, ... for *y*.
[init_location]	name	string	sets your location's name. This is an arbitrary string, For example, *Paris*
[init_location]	latitude	DMS	sets the latitude coordinate of the observer. Value is in degrees, minutes, seconds. Positive degree values mean North / negative South. e.g. *+55d14'30.00"*

Section	*ID*	*Type*	*Description*
[init_location]	longitude	DMS	sets the longitude coordinate of the observer. Value is in degrees, minutes, seconds. Positive degree values mean East / negative West. e.g. *-01d37'6.00"*
[init_location]	altitude	float	observer's altitude above mean sea level in meters, e.g. *53*
[init_location]	landscape_name	string	sets the landscape you see. Other options are *garching, guereins, trees, moon, ocean, hurricane, hogerielen*
[init_location]	time_zone	string	sets the time zone. Valid values: *system*_default, or some region/location combination, e.g. *Pacific*/*Marquesas*
[init_location]	time_display_format	string	set the time display format mode: can be *system_default*, *24h* or *12h*.
[init_location]	date_display_format	string	set the date display format mode: can be *system_default*, *mddyyyy*, *ddmmyyyy* or *yyyymmdd* (ISO8601).
[init_location]	home_planet	string	name of solar system body on which to start stellarium. This may be set at runtime from the TUI menu.
[files]	removable_media_path	string	Path to removable media (CD/DVD). This is usually only used in Digitalis planetarium products.
[files]	scripts_can_write_files	bool	Some scripting commands will cause files to be written. Unless this option is set to true, these scripting commands will fail.

Appendix B

Scripting Commands

Command	*Argument Names*	*Argument Values*	*Notes*
audio	action	pause play sync	Audio functions are only available if Stellarium was compiled with the audio options. If this is not the case, a message should be printed at startup to the terminal (OSX, Linux) or stdout.txt (Windows) stating, “This executable was compiled without audio support.”
	filename	AUDIO_FILENAME	Used with "play" action. Format support depends on your binary. Ogg Vorbis format is recommended. WAV format should work but is discouraged because in this case the audio track will not adjust if the script is fast forwarded. [This is a current limitation of the SDL_Mixer library.]
	loop	on off	Used with "play" action. Default is off
	output_rate	SAMPLES_PER_SECOND	For example, 44100 is CD quality audio.
	pause		
	play		
	sync		
	volume	decrement increment VOLUME_LEVEL	VOLUME_LEVEL is between 0 and 1, inclusive.
clear	state	natural	Turn off fog and all labels, lines, and art. Turn planet, star, and nebula rendering on. Deselect any selected objects. Return to initial fov and viewing direction. If state is natural, ground and atmosphere will be turned on, otherwise these will be turned off.
date	local	[[-]YYYY-MM-DD]Thh:mm:ss	Set time to a specified date and/or time using current timezone. ’T’ is literal.
	utc	[-]YYYY-MM-DDThh:mm:ss	Set time to a specified date and time in UTC time. ’T’ is literal.
	relative	DAYS	Change date and time by DAYS (can be fractional).
	load	current	Set date to current date.
deselect			Deselects current object selection, including any constellation selection. See select command.

Command	*Argument Names*	*Argument Values*	*Notes*
flag	atmosphere azimuthal_grid bright_nebulae cardinal_points chart constellation_art constellation_boundaries constellation_drawing constellation_names constellation_pick ecliptic_line enable_move_keys enable_tui_menu enable_zoom_keys equator_line equatorial_grid fog gravity_labels help infos moon_scaled landscape landscape_sets_location manual_zoom menu meridian_line milky_way nebulae nebula_names night object_trails planets planet_names planet_orbits point_star script_gui_debug show_appname show_date show_fov show_fps show_gravity_ui show_script_bar show_selected_object_info show_time show_topbar show_tui_datetime show_tui_short_obj_info star_names star_twinkle stars track_object	on 1 off 0 toggle	Set rendering flags. One argument name per command allowed currently. track_object is only useful while an object is selected. The following flags are key user settings and are not accessible from scripts: enable_move_keys enable_move_mouse enable_tui_menu enable_zoom_keys gravity_labels help horizon infos menu show_appname show_date show_fov show_fps show_gravity_ui show_time show_topbar utc_time
image	action	load drop	Drop images when no longer needed to improve performance.

Command	*Argument Names*	*Argument Values*	*Notes*
	altitude	ALTITUDE_ANGLE	For positioning the center of the image in horizontal coordinates. Zero is at the horizon, 90 is at the zenith.
	azimuth	AZIMUTH_ANGLE	For positioning the center of the image in horizontal coordinates. Zero is North, 90 is East.
	coordinate_system	viewport horizontal	What coordinate system to use to position the image. Must be defined at image load. Can not be changed later. Default is viewport.
	drop	name	drops named image from memory
	duration	SECONDS	How long to take to complete the command.
	filename	IMAGE_FILENAME	Path must be relative to script. Image file should be PNG or JPEG format
	name	IMAGE_NAME	Used to refer to the image in later calls to manipulate the image. Images must be in PNG format. Images should have dimensions that 2 raised to integer powers of 2 (128, 256, etc.).
	alpha	ALPHA	0 is transparent (default), 1 is opaque. ALPHA can be fractional. Note that images are drawn in the order they were loaded.
	scale	SCALE	How large to draw the image. In viewport coordinates, at 1 the image is scaled to fit maximized in the viewport. In horizontal coordinates, this defines the maximum angular width of the image in degrees.
	rotation	DEGREES	Absolute rotation, positive is clockwise.
	xpos	X_POSITION	Where to draw center of image. 0 is center of viewport, 1 is right edge of viewport.
	ypos	Y_POSITION	Where to draw center of image. 0 is center of viewport, 1 is top edge of viewport.
landscape	load	[variable]	Load a landscape. Arguments have same names and possible values as in a landscape.ini file except that texture file names need to be specified in full including the path relative to the script. Also add argument "action load"
meteors	zhr	ZENITH_HOURLY_RATE	Integer number
look	delta_az	RADIANS	Change the viewing angle by RADIANS (azimuth)
	delta_alt	RADIANS	Change the viewing angle by RADIANS (altitude)
moveto	lat	LATITUDE	South is negative
	lon	LONGITUDE	West is negative
	alt	ALTITUDE	In meters
	duration	SECONDS	How long to take to effect this change.
script	action	play end pause resume record cancelrecord	Note that pause toggles playback. If a script plays another script, the first will terminate.
	filename	SCRIPT_FILENAME	
screenshot	prefix	filename prefix	The prefix for the screenshot file name. A numerical incrementing value will be added to this for each screenshot, and the filename extension. You must supply this option. Note that the scripts_can_write_files option in the files section of the config.ini file *must* be set to true for this command to work.
	dir	screenshot directory	The directory in which the screenshot will be saved.
select			If no arguments are supplied, deselects current object. (Leaves constellation selection alone.) See deselect command.

Command	*Argument Names*	*Argument Values*	*Notes*
	constellation	CONSTELLATION_SHORT_NAME	3 character abbreviation from constellationship.fab, case insensitive.
	constellation_star	HP_NUMBER	Select the constellation which is made up by the specified star
	hp	HP_NUMBER	Integer Hipparcos catalogue number
	nebula	NEBULA_NAME	Name as defined in nebula_textures.fab
	planet	PLANET_NAME	Name as defined in ssystem.ini
	pointer	on 1 off 0	Whether to draw the highlighting pointer around the selected object. Default is on.
set	atmosphere_fade_duration	SECONDS	Number of seconds it takes for atmosphere toggle to complete
	auto_move_duration	SECONDS	Used for auto zoom
	constellation_art_fade_duration	SECONDS	Number of seconds it takes for constellation art toggle to complete
	constellation_art_intensity	0.0 .. 1.0	Floating point number between 0 and 1
	home_planet	PLANET_NAME	The planet name comes from the ssystem.ini file. It is case sensitive
	landscape_name	LANDSCAPE_NAME	The landscape ID (the name of the directory in which the landscape.ini file and texture files exist
	max_mag_nebula_name	MAGNITUDE	Floating point apparent magnitude value. Only label nebulas brighter than this
	max_mag_star_name	MAGNITUDE	Floating point apparent magnitude value. Only label nebulas brighter than this
	milky_way_intensity	INTENSITY	Decimal number. 1 is normal brightness
	moon_scale	SCALE	1 is real size
	nebula_scale	SCALE	
	sky_culture	CUTURE_NAME	Directory name from skycultures.fab
	sky_locale	LOCATE_ID	3 letter code. eng, fra, etc.
	star_mag_scale	MAG_SCALE	
	star_scale	SCALE	
	star_twinkle_amount	AMOUNT	0 is no twinkling
	time_zone	ZONE	System dependent
timerate	rate	SECONDS_PER_SECOND	Set simulation time rate.
	pause		pause time
	resume		resume time after pause
	increment		increase time rate
	decrement		decrease time rate
wait	duration	SECONDS	Only useful in scripts. SECONDS can be fractional.
zoom	auto	in initial out	"initial" returns to configured initial fov and viewing direction
	fov	FIELD_OF_VIEW	in degrees
	delta_fov	DELTA_DEGREES	
	duration	SECONDS	Not used with delta_fov

Appendix C

Precision

Stellarium uses the VSOP87 method to calculate the variation in position of the planets over time.

As with other methods, the precision of the calculations vary according to the planet and the time for which one makes the calculation. Reasons for these inaccuracies include the fact that the motion of the planet isn't as predictable as Newtonian mechanics would have us believe.

As far as Stellarium is concerned, the user should bear in mind the following properties of the VSOP87 method. Precision values here are positional as observed from Earth.

Object(s)	*Method*	*Notes*
Mercury, Venus, Earth-Moon barycenter, Mars	VSOP87	Precision is 1 arc-second from 2000 B.C. - 6000 A.D.
Jupiter, Saturn	VSOP87	Precision is 1 arc-second from 0 A.D. - 4000 A.D.
Uranus, Neptune	VSOP87	Precision is 1 arc-second from 4000 B.C - 8000 A.D.
Pluto	?	Pluto's position is valid from 1885 A.D. -2099 A.D.
Earth's Moon	ELP2000-82B	Unsure about interval of validity or precision at time of writing. Possibly valid from 1828 A.D. to 2047 A.D.
Galilean satellites	L2	Valid from 500 A.D - 3500 A.D.

Appendix D

TUI Commands

1	Set Location	(menu group)
1.1	Latitude	Set the latitude of the observer in degrees
1.2	Longitude	Set the longitude of the observer in degrees
1.3	Altitude (m)	Set the altitude of the observer in meters
1.4	Solar System Body	Select the solar system body on which the observer is
2	Set Time	(menu group)
2.1	Sky Time	Set the time and date for which Stellarium will generate the view
2.2	Set Time Zone	Set the time zone. Zones are split into continent or region, and then by city or province
2.3	Days keys	The setting "Calendar" makes the `- = [ ]` and keys change the date value by calendar days (multiples of 24 hours). The setting "Sidereal" changes these keys to change the date by sidereal days
2.4	Preset Sky Time	Select the time which Stellarium starts with (if the "Sky Time At Start-up" setting is "Preset Time"
2.5	Sky Time At Start-up	The setting "Actual Time" sets Stellarium's time to the computer clock when Stellarium runs. The setting "Preset Time" selects a time set in menu item "Preset Sky Time"
2.6	Time Display Format	Change how Stellarium formats time values. "system default" takes the format from the computer settings, or it is possible to select 24 hour or 12 hour clock modes
2.7	Date Display Format	Change how Stellarium formats date values. "system default" takes the format from the computer settings, or it is possible to select "yyyymmdd", "ddmmyyyy" or "mmddyyyy" modes
3	General	(menu group)
3.1	Sky Culture	Select the sky culture to use (changes constellation lines, names, artwork)
3.2	Sky Language	Change the language used to describe objects in the sky
4	Stars	(menu group)
4.1	Show	Turn on/off star rendering

4.2	Star Magnitude Multiplier	Can be used to change the brightness of the stars which are visible at a given zoom level. This may be used to simulate local seeing conditions - the lower the value, the less stars will be visible
4.3	Maximum Magnitude to Label	Changes how many stars get labelled according to their apparent magnitude (if star labels are turned on)
4.4	Twinkling	Sets how strong the star twinkling effect is - zero is off, the higher the value the more the stars will twinkle.
5	Colors	(menu group)
5.1	Constellation Lines	Changes the colour of the constellation lines
5.2	Constellation Names	Changes the colour of the labels used to name stars
5.3	Constellation Art Intensity	Changes the brightness of the constellation art
5.4	Constellation Boundaries	Changes the colour of the constellation boundary lines
5.5	Cardinal Points	Changes the colour of the cardinal point markers
5.6	Planet Names	Changes the colour of the labels for planets
5.7	Planet Orbits	Changes the colour of the orbital guide lines for planets
5.8	Planet Trails	Changes the colour of the planet trail lines
5.9	Meridian Line	Changes the colour of the meridian line
5.10	Azimuthal Grid	Changes the colour of the lines and labels for the azimuthal grid
5.11	Equatorial Grid	Changes the colour of the lines and labels for the equatorial grid
5.12	Equator Line	Changes the colour of the equator line
5.13	Ecliptic Line	Changes the colour of the ecliptic line
5.14	Nebula Names	Changes the colour of the labels for nebulae
5.15	Nebula Circles	Changes the colour of the circles used to denote the positions of nebulae (only when enabled int he configuration file, note this feature is off by default)
6	Effects	(menu group)
6.1	Light Pollution Luminance	Changes the intensity of the light pollution simulation
6.2	Landscape	Used to select the landscape which Stellarium draws when ground drawing is enabled
6.3	Manual zoom	Changes the behaviour of the `/` and `\` keys. When set to "No", these keys zoom all the way to a level defined by object type (auto zoom mode). When set to "Yes", these keys zoom in and out a smaller amount and multiple presses are required
6.4	Object Sizing Rule	When set to "Magnitude", stars are drawn with a size based on their apparent magnitude. When set to "Point" all stars are drawn with the same size on the screen
6.5	Magnitude Sizing Multiplier	Changes the size of the stars when "Object Sizing Rule" is set to "Magnitude"
6.6	Milky Way intensity	Changes the brightness of the Milky Way texture
6.7	Maximum Nebula Magnitude to Label	Changes the magnitude limit for labelling of nebulae
6.8	Zoom Duration	Sets the time for zoom operations to take (in seconds)
6.9	Cursor Timeout	Sets the number of seconds of mouse inactivity before the cursor vanishes

6.10	Setting Landscape Sets Location	If “Yes” then changing the landscape will move the observer to the location for that landscape (if one is known). Setting this to “No” means the observer location is not modified when the landscape is changed
7	Scripts	(menu group)
7.1	Local Script	Run a script from the scripts sub-directory of the User Directory or Installation Directory (see section 5.1)
7.2	CD/DVD Script	Run a script from a CD or DVD (only used in planetarium set-ups)
8	Administration	(menu group)
8.1	Load Default Configuration	Reset all settings according to the main configuration file
8.2	Save Current Configuration as Default	Save the current settings to the main configuration file
8.3	Shutdown	Quit Stellarium
8.4	Update me via Internet	Only used in planetarium set-ups
8.5	Set UI Locale	Change the language used for the user interface

Appendix E

Star Catalogue

This document describes how Stellarium records it's star catalogues, and the related file formats.

E.1 Stellarium's Sky Model

E.1.1 Zones

The celestial sphere is split into zones, which correspond to the triangular faces of a geodesic sphere. The number of zones (faces) depends on the level of sub-division of this sphere. The lowest level, 0, is an icosahedron (20 faces), subsequent levels, L, of sub-division give the number of zones, n as:

$$n = 20 \cdot 4^L$$

Stellarium uses levels 0 to 7 in the existing star catalogues. Star Data Records contain the position of a star as an offset from the central position of the zone in which that star is located, thus it is necessary to determine the vector from the observer to the centre of a zone, and add the star's offsets to find the absolute position of the star on the celestial sphere.

This position for a star is expressed as a 3-dimensional vector which points from the observer (at the centre of the geodesic sphere) to the position of the star as observed on the celestial sphere.

E.2 Star Catalogue File Format

E.2.1 General Description

Stellarium's star catalogue data is kept in the stars/default sub-directory of the Installation Directory and/or User Directory (see section 5.1).

The main catalogue data is split into several files:

- `stars_0_0v0_1.cat`
- `stars_1_0v0_1.cat`
- `stars_2_0v0_1.cat`
- `stars_3_0v0_0.cat`
- `stars_4_1v0_0.cat`

- `stars_5_1v0_0.cat`
- `stars_6_2v0_0.cat`
- `stars_7_2v0_0.cat`
- `stars_8_2v0_0.cat`

There also exist some control and reference files:

- `stars_hip_cids_0v0_0.cat`
- `stars_hip_sp_0v0_0.cat`
- `stars.ini`
- `name.fab`

When Stellarium starts, it reads the `stars.ini` file, from which it determines the names of the other files, which it then loads.

The `stars_hip_cids_0v0_0.cat` and `stars_hip_sp_0v0_0.cat` files contain reference data for the main catalogue files.

A given catalogue file models stars for one and only one level (i.e. for a fixed number of zones), which is recorded in the header of the file. Individual star records do not contain full positional coordinates, instead they contain coordinates relative to the central position of the zone they occupy. Thus, when parsing star catalogues, it is necessary to know about the zone model to be able to extract positional data.

File	*Data Type*[1]	*Data Record Size*	*Geodesic Level*	*#Records*	*Notes*
stars_0_0v0_1.cat	0	28 bytes	0	5,013	Hipparcos
stars_1_0v0_1.cat	0	28 bytes	1	21,999	Hipparcos
stars_2_0v0_1.cat	0	28 bytes	2	151,516	Hipparcos
stars_3_1v0_0.cat	1	10 bytes	3	434,064	Tycho
stars_4_1v0_0.cat	1	10 bytes	4	1,725,497	Tycho
stars_5_2v0_0.cat	2	8 bytes	5	7,669,011	NOMAD
stars_6_2v0_0.cat	2	8 bytes	6	26,615,233	NOMAD
stars_7_2v0_0.cat	2	8 bytes	7	57,826,266	NOMAD
stars_8_2v0_0.cat	2	8 bytes	7	116,923,084	NOMAD

Table E.2: Stellarium's star catalogue files

For a given catalogue file, there may be one of three formats for the actual star data. The variation comes from the source of the data - the larger catalogues of fainter stars providing less data per star than the brighter star catalogues. See tables E.2 and for details.

E.2.2 File Sections

The catalogue files are split into three main sections as described in table **??**.

Name	*Offset*	*Type*	*Size*	*Description*
Magic	0	int	4	The magic number which identifies the file as a star catalogue. `0xde0955a3`
Data Type	4	int	4	This describes the type of the file, which defines the size and structure of the Star Data record for the file.
Major Version	8	int	4	The file format major version number
Minor Version	12	int	4	The file format minor version number
Level	16	int	4	Sets the level of sub-division of the geodesic sphere used to create the zones. 0 means an icosahedron (20 sizes), subsequent levels of sub-division lead to numbers of zones as described in section E.1.1
Magnitude Minimum	20	int	4	The low bound of the magnitude scale for values in this file. Note that this is still an integer in Stellarium's own internal representation
Magnitude Range	24	int	4	The range of magnitudes expressed in this file
Magnitude Steps	28	int	4	The number of steps used to describes values in the range

Section	*Offset*	*Description*
File Header Record	0	Contains magic number, geodesic subdivision level, and magnitude range
Zone Records	32	A list of how many records there are for each zone. The length of the zones section depends on the level value from the header
Star Data Records	$32+4n$	This section of the file contains fixed-size star records, as described below. Records do not contain zone information, which must be inferred by counting how many records have been read so far and switching zones when enough have been read to fill the number of stars for the zone, as specified in the zones section above. The value of n used in the offset description is the number of zones, as described above.

E.2.3 Record Types

E.2.3.1 File Header Record

The *File Header Record* describes file-wide settings. It also contains a *magic number* which servers as a file type identifier. See table **??**.

Name	*Offset*	*Type*	*Size*	*Description*
num stars in zone 0	0	int	4	The number of records in this file which are in zone 0
num stars in zone 1	4	int	4	The number of records is this file which are in zone 1
...				
num stars in zone *n*	4*n*	int	4	The number of records is this file which are in zone *n*

E.2.3.2 Zone Records

The *Zone Records* section of the file lists the number of star records there are per zone. The number of zones is determined from the level value in the File Header Record, as described in section E.1.1. The Zones section is simply a list of integer values which describe the number of stars for each zone. The total length of the Zones section depends on the number of zones. See table **??**.

E.2.3.3 Star Data Records

After the Zones section, the actual star data starts. The star data records themselves do not contain the zone in which the star belongs. Instead, the zone is inferred from the position of the record in the file. For example, if the Zone Records section of the file says that the first 100 records are for zone 0, the next 80 for zone 1 and so on, it is possible to infer the zone for a given record by counting how many records have been read so far.

The actual record structure depends on the value of the Data Type, as found in the File Header Record.

See tables **??**, E.8and **??** for record structure details.

It should be noted that although the positional data loses accuracy as one progresses though the Star Record Types, this is compensated for by the face that the number of zones is much higher for the files where the smaller precision position fields are used, so the actual resolution on the sky isn't significantly worse for the type 1 and 2 records in practice.

Name	*Offset*	*Type*	*Size*	*Description*
hip	0	int	3	Hipparcos catalogue number
component_ids	3	unsigned char	1	This is an index to an array of catalogue number suffixes. The list is read from the `stars_hip_component_ids.cat` file. The value of this field turns out to be the line number in the file - 1
x0	4	int	4	This is the position of the star relative to the central point in the star's zone, in axis 1
x1	8	int	4	This is the position of the star relative to the central point in the star's zone, in axis 2
b_v	9	unsigned char	1	This is the magnitude level in B-V colour. This value refers to one of 256 discrete steps in the magnitude range for the file
mag	10	unsigned char	1	This is the magnitude level in the V-I colour. This value refers to one of 256 discrete steps in the magnitude range for the file
sp_int	11	unsigned short int	2	This is the index in an array of spectral type descriptions which is taken from the file `stars_hip_sp.cat`, the index corresponds to the line number in the file - 1
dx0	13	int	4	This is the proper motion of the star in axis 1
dx1	17	int	4	This is the proper motion of the star in axis 2
plx	21	int	4	This is the parallax of the star. To get the actual value, divide by 10000.

Name	*Offset*	*Type*	*Size*	*Description*
x0	0	int	20 bits	This is the position of the star relative to the central point in the star's zone, in axis 1
x1	20 bits	int	20 bits	This is the position of the star relative to the central point in the star's zone, in axis 2
dx0	40 bits	int	14 bits	This is the proper motion of the star in axis 1
dx1	54 bits	int	14 bits	This is the proper motion of the star in axis 2
b_v	68 bits	unsigned int	7 bits	This is the magnitude level in B-V colour. This value refers to one of 256 discrete steps in the magnitude range for the file
mag	75 bits	unsigned int	5 bits	This is the magnitude level in the V-I colour. This value refers to one of 256 discrete steps in the magnitude range for the file

Table E.8: Star Data Record Type 1

Name	*Offset*	*Type*	*Size*	*Description*
x0	0	int	18 bits	This is the position of the star relative to the central point in the star's zone, in axis 1
x1	18 bits	int	18 bits	This is the position of the star relative to the central point in the star's zone, in axis 2
b_v	36 bits	unsigned int	7 bits	This is the magnitude level in B-V colour. This value refers to one of 256 discrete steps in the magnitude range for the file
mag	43 bits	unsigned int	5 bits	This is the magnitude level in the V-I colour. This value refers to one of 256 discrete steps in the magnitude range for the file

Appendix F

Creating a Personalised Landscape for Stellarium

by Barry Gerdes, 2005-12-19[1]

Although this procedure is based on the Microsoft Windows System the basics will apply to any platform that can run the programs mentioned or similar programs on the preferred system.

The first thing needed for a personalised landscape to superimpose on the horizon display is a 360° panorama with a transparent background. To make this you will need the following:

- A digital camera on a tripod or stable platform
- A program to convert the pictures into a 360° panorama
- A program to remove the background and convert the panorama into about 8 square pictures in PNG format for insertion into Stellarium as the sides and if possible a similar square picture of the base you are standing on to form the ground. This last requirement is only really possible if this area is relatively featureless as the problem of knitting a complex base is well nigh impossible.
- Patience. (Maybe a soundproof room so that the swearing wont be heard when you press the wrong key and lose an hours work)

F.0.4 The Camera

Digital cameras are easy and cheaply available these days so whatever you have should do. One mega-pixel resolution is quite sufficient.

The camera needs to be mounted on a tripod so that reasonably orientated pictures can be taken. Select a time of day that is quite bright with a neutral cloudy sky so there will be no shadows and a sky of the same overall texture. This will make it easier to remove later. The pictures were all saved in the JPG format which was used as the common format for all processes up to the removal of the background.

With a camera that takes 4:3 ratio pictures I found 14 evenly spaced pictures gave the best 360° panorama in the program I used to produce it.

[1] *Since this guide was written, the newer, simpler-to-use landscape type "spherical" has been implemented. This guide should be re-written using this simple mechanism - submissions very welcome!*

Figure F.1: 360° panorama

F.0.5 Processing into a Panorama

This is the most complicated part of the process of generating the panorama. I used two separate programs to do this. Firstly I used Microsoft Paint which is part of the Windows operating system, to cleanup and resize the pictures to 800x600 size and so make them easier to handle in the panorama program.

If you have prominent foreground items like posts wires etc. that occur in adjacent pictures the panorama program will have difficulty in discerning them because of the 3D effect and may give double images. I overcame this by painting out the offending item by cut and paste between the two pictures. Quite easy with a little practice using the zoom in facility and I found the MSpaint program the easiest to do this in.

When I had my 14 processed pictures I inserted them into the panorama program. I used a program called the Panorama Factory. Version 1.6 is a freebee that works well and can be downloaded from the internet - a Google search will find it. I used version 3.4 that is better and cost about $40 off the Internet. This program has many options and can be configured to suit most cameras and can make a seamless 360° panorama in barrel form that will take a highly trained eye to find where the joins occur.

The resulting panorama was then loaded into Paint and trimmed to a suitable size. Mine ended up 4606 x 461 pixels. I stretched the 4606 to 4610 pixels, almost no distortion, that would allow cutting into 10 461x461 pictures at a later date. If the height of the panorama had been greater I could have made fewer pictures and so shown more of the foreground. See figure F.1.

F.0.6 Removing the background to make it transparent

This is the most complex part of the process and requires a program that can produce transparency to parts of your picture, commonly called an alpha channel. Two programs I know of will do this. The very expensive and sophisticated Adobe Photoshop and a freebee called The Gimp.

I used Photoshop to produce the alpha channel because selection of the area for transparency was more positive with the complex skyline I had and I had learnt a little more on how to drive it before I found an executable form of The Gimp. For the rest I used a combination of both programs. I will describe the alpha channel process in detail for Photoshop. A lot of this would be suitable for The Gimp as they are very similar programs but I have only tried the bare essential in The Gimp to prove to myself that it could be done.

1. Load the panorama picture into Photoshop

2. Create an alpha channel using the channel pop up window. This channel was then selected as the only channel visible and it was all black at this stage. It needs to be all white. To edit this took me some time to discover how. What I did was click on Edit in Quick mask mode and then Edit in standard mode. This procedure was the only way I found I could edit. Click on the magic wand and click it on the channel picture. It will put a mask around the whole picture. Next I selected the brush tool and toggled the foreground to white and painted the whole channel white (using a very large brush size 445 pixels).

3. Next I turned the alpha channel off and selected the other channels to get the original picture. I got rid of the full mask that I had forgotten to remove by selecting Step backwards from the edit menu. I first tried the magnetic loop tool to select the

sections for a mask but it was too fiddly for me. I then used the magic wand tool to select the sky sections bit by bit (zoom in on the image to see what you are doing) this would have been easy if the sky had been cloudless because colour match does this selection. I cut each selection out. It took about an hour to remove all the sky (because it was cloudy) and leave just the skyline image as a suitable mask. Clicking the magic wand in the sky area when all the sky has been removed will show an outline mask of the removed sky. Zoom in and carefully check the whole area to make sure there is no sky left. Leave this mask there.

4. Re-select the alpha channel and turn the other channels off. The alpha channel will be visible and the mask should be showing. Re-select Edit in Quick mask mode and then Edit in standard mode to edit. Select the brush tool and toggle to the black foreground. Fill in the masked area with a large brush size. The colour (black) will only go into the masked area. It wont spill over so the job is quite easy.

5. When this is done you will have created your alpha layer. Check the size of the image and if it is greater than 5000 pixels wide reduce its size by a fixed percentage till it is under this limit. The limit was necessary for one of the programs I used but may not be always necessary. However any greater resolution will be wasted and the file size will be excessive. Save the whole image in the compressed tiff form or PNG form. The only formats that preserve the alpha channel.

6. This image is the horizon picture. Give it a name .tif or .png, whichever format you save it in.

   After making the `panorama.tif` I noticed that the trees still had areas of the original sky embedded that were not blanked by the alpha layer. I found that I could add these sections piece by piece to the alpha layer with the magic wand and paint them out. This took some time, as there were a large number to be removed. However the result was worth the effort, as it allows the sky display to be seen through the trees. Especially at high zooms ins.

   Another little trick I discovered was that the panorama could be saved as a JPEG file (no alpha channel) and the alpha channel also saved as a separate JPEG file. This can save space for transmission. And allow manipulation of the original file in another program as long as the skyline is unchanged. At a later date the two files can be re-combined in Photoshop to re-form the TIFF file with alpha channel.

   Using this trick I did a little patching and painting on the original picture in Paint on the original JPEG form. When completed I loaded it into Photoshop and added the blank alpha channel to it. I was then able to paste the previously created alpha layer into the new picture. It worked perfectly.

7. The panorama now needs to be broken up into suitable square images for insertion into a landscape. It took me some time to get the hang of this but the process I found best was in The Gimp. It was the easiest to cut the main panorama into sections as it has a mask scale in the tool bar.

8. Load the panorama file with alpha channel into The Gimp. Then using the mask tool cut out the squares of the predetermined size starting from the left hand side of the picture. I don't think it is necessary to make them exact squares but I did not experiment with this aspect. The position of the cut will be shown on the lower tool bar. Accuracy is improved if you use the maximum zoom that will fit on the page.

9. Create a new picture from the file menu then select and adjust the size to your predetermined size then select transparent for the background. Because of the alpha channel the transparent section will be automatically clipped of much of the transparent part of the picture. Paste the cutting into the new picture. If it is smaller

than your predetermined size it will go to the centre leaving some of the transparent background at the bottom of the picture. Save the file in the PNG format. Moving the picture to the bottom of the window is much easier in Photoshop although quite possible in The Gimp.

10. I repeated steps 8 and 9 till I had all sections of the panorama saved.

11. Next I re-loaded Photoshop and opened the first of the saved pictures. Then from the menu selected the picture with the mask tool and then selected move. Next clicking on the picture will cut it out. The cutting can now be dragged to the bottom of the frame. It will not go any further so there is no trouble aligning. This bottom stop did not work on The Gimp and so it was harder to cut and place the picture section. It is most important to align the pictures to the bottom.

12. Save the picture with the name you intend to call your landscape as `xxxxxx1.png`.

13. Repeat steps 11 and 12 for the rest of the pictures till you have all the elements for your landscape.

14. Make a new directory for the landscape. This should be a sub-directory of either the `<user directory>/landscapes` or `<installation>/landscapes` directory. The name of the directory should be unique to your landscape, and is the *landscape ID*. The convention is to use a single descriptive word in lowercase text, for example `gueriens`. Place your pictures your new directory.

15. In your new landscape directory, create a new file called `landscape.ini` file (I used wordpad). Add a line for the `[landscape]` section. It's probably easiest to copy the `landscape.ini` file for the Gueriens landscape and edit it. Edit the name Guereins in every instance to the name you have given your landscape. Don't forget to make the number of `tex` entries agree with the number of your pictures. If you haven't made a `groundtex` picture use one of the existing ones from the file or make a square blank picture of your own idea. Because I took my pictures from the roof of the house I used an edited picture of the roof of my house from Google Earth. It was pretty cruddy low resolution but served the purpose.

16. Next you need to orientate your picture North with true North. This is done roughly by making the arrangement of `side1` to `side`*n* suit your site as close as possible. Now you need to edit the value of `decor_angle_rotatez` to move your landscape in azimuth. Edit `decor_alt_angle` to move you landscape in altitude to align your visible horizon angle. Edit `ground_angle_rotatez` to align your ground with the rest of the landscape. Leave the other entries they are suitable as is.

After re-starting Stellarium, your landscape will appear in the landscape tab of the configuration window, and can be selected as required.

Appendix G

Astronomical Concepts

This section includes some general notes on astronomy in an effort to outline some concepts that are helpful to understand features of Stellarium. Material here is only an overview, and the reader is encouraged to get hold of a couple of good books on the subject. A good place to start is a compact guide and ephemeris such as the National Audubon Society Field Guide to the Night Sky[3]. Also recommended is a more complete textbook such as Universe[4]. There are also some nice resources on the net, like the Wikibooks Astronomy book[5].

G.1 The Celestial Sphere

The *Celestial Sphere* is a concept which helps us think about the positions of objects in the sky. Looking up at the sky, you might imagine that it is a huge dome or top half of a sphere, and the stars are points of light on that sphere. Visualising the sky in such a manner, it appears that the sphere moves, taking all the stars with it—it seems to rotate. If watch the movement of the stars we can see that they seem to rotate around a static point about once a day. Stellarium is the perfect tool to demonstrate this!

1. Open the configuration window, select the location tab. Set the location to be somewhere in mid-Northern latitudes. The United Kingdom is an ideal location for this demonstration.

2. Turn off atmospheric rendering and ensure cardinal points are turned on. This will keep the sky dark so the Sun doesn't prevent us from seeing the motion of the stars when it is above the horizon.

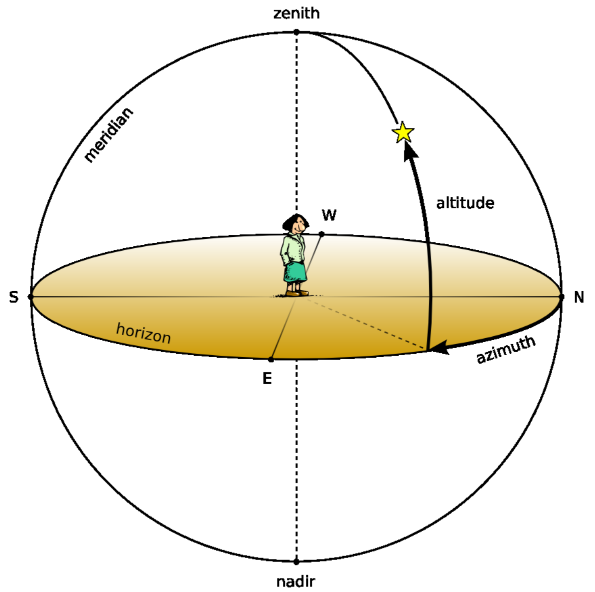
3. Pan round to point North, and make sure the field of view is about 90°.

4. Pan up so the 'N' cardinal point on the horizon is at the bottom of the screen.

5. Now increase the time rate. Press `k`, `l`, `l`, `l`, `l` - this should set the time rate so the stars can be seen to rotate around a point in the sky about once every ten seconds If you watch Stellarium's clock you'll see this is the time it takes for one day to pass as this accelerated rate.

The point which the stars appear to move around is one of the *Celestial Poles*.

The apparent movement of the stars is due to the rotation of the Earth. The location of the observer on the surface of the Earth affects how she perceives the motion of the stars. To an observer standing at Earth's North Pole, the stars all seem to rotate around the *zenith* (the point directly upward). As the observer moves South towards the equator, the location of the celestial pole moves down towards the horizon. At the Earth's equator, the North celestial pole appears to be on the Northern horizon.



Similarly, observers in the Southern hemisphere see the Southern celestial pole at the zenith when they are at the South pole, and it moves to the horizon as the observer travels towards the equator.

1. Leave time moving on nice and fast, and open the configuration window. Go to the location tab and click on the map right at the top - i.e. set your location to the North pole. See how the stars rotate around a point right at the top of the screen. With the field of view set to 90° and the horizon at the bottom of the screen, the top of the screen is the zenith.

2. Now click on the map again, this time a little further South, You should see the positions of the stars jump, and the centre of rotation has moved a little further down the screen.

3. Click on the map even further towards and equator. You should see the centre of rotation have moved down again.

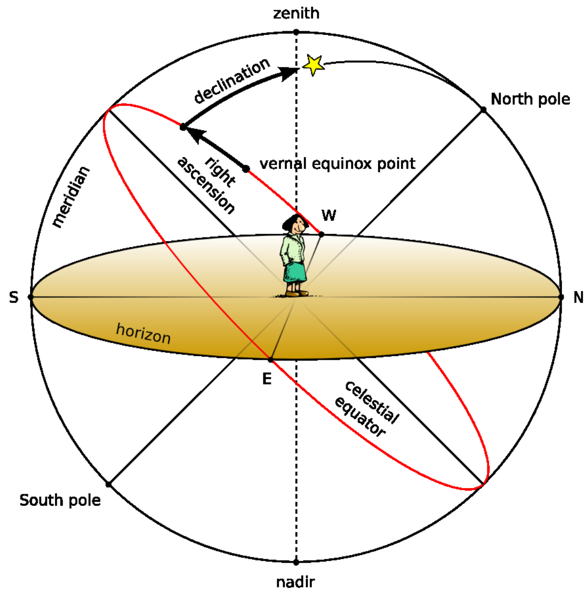
To help with the visualisation of the celestial sphere, turn on the equatorial grid by clicking the button on the main tool-bar or pressing the on the `e` key. Now you can see grid lines drawn on the sky. These lines are like lines of longitude and latitude on the Earth, but drawn for the celestial sphere.

The *Celestial Equator* is the line around the celestial sphere that is half way between the celestial poles - just as the Earth's equator is the line half way between the Earth's poles.

G.2 Coordinate Systems

G.2.1 Altitude/Azimuth Coordinates

The *Altitude/Azimuth* coordinate system can be used to describe a direction of view (the azimuth angle) and a height in the sky (the altitude angle). The azimuth angle is measured clockwise round from due North. Hence North itself is °, East 90°, Southwest is 135° and so on. The altitude angle is measured up from the horizon. Looking directly up (at the



zenith) would be 90°, half way between the zenith and the horizon is 45° and so on. The point opposite the zenith is called the *nadir*.

The Altitude/Azimuth coordinate system is attractive in that it is intuitive - most people are familiar with azimuth angles from bearings in the context of navigation, and the altitude angle is something most people can visualise pretty easily.

However, the altitude/azimuth coordinate system is not suitable for describing the general position of stars and other objects in the sky - the altitude and azimuth values for an object in the sky change with time and the location of the observer.

Stellarium can draw grid lines for altitude/azimuth coordinates. Use the button on the main tool-bar to activate this grid, or press the `z` key.

G.2.2 Right Ascension/Declination Coordinates

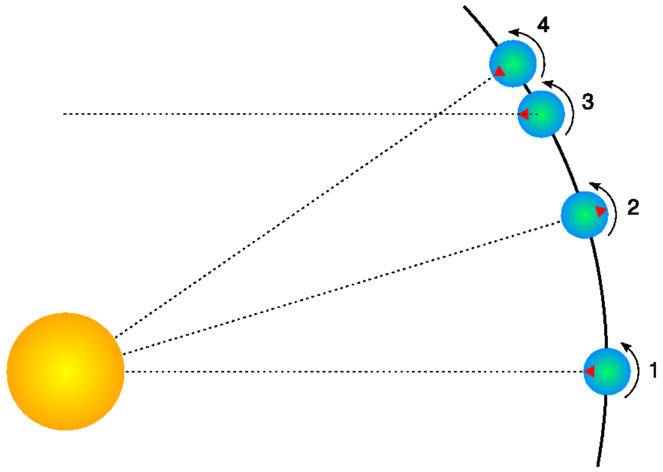
Like the Altitude/Azimuth system, the *Right Ascension*/*Declination* (RA/Dec) coordinate system uses two angles to describe positions in the sky. These angles are measured from standard points on the celestial sphere. Right ascension and declination are to the celestial sphere what longitude and latitude are to terrestrial map makers.

The Northern celestial pole has a declination of 90°, the celestial equator has a declination of °, and the Southern celestial pole has a declination of -90°.

Right ascension is measured as an angle round from a point in the sky known as the *first point of Aries*, in the same way that longitude is measured around the Earth from Greenwich. Figure **??** illustrates RA/Dec coordinates.

Unlike Altitude/Azimuth coordinates, RA/Dec coordinates of a star do not change if the observer changes latitude, and do not change over the course of the day due to the rotation of the Earth (the story is complicated a little by precession and parallax - see sections G.4 and G.5 respectively for details). RA/Dec coordinates are frequently used in star catalogues such as the Hipparcos catalogue.

Stellarium can draw grid lines for RA/Dec coordinates. Use the button on the main tool-bar to activate this grid, or press the `e` key.



G.3 Units

G.3.1 Distance

As Douglas Adams pointed out in the Hitchhiker's Guide to the Galaxy[1],

> Space is big. You just won't believe how vastly, hugely, mind-bogglingly big it is. I mean, you may think it's a long way down the road to the chemist's, but that's just peanuts to space.[1]

Astronomers use a variety of units for distance that make sense in the context of the mind-boggling vastness of space.

Astronomical Unit (AU) This is the mean Earth-Sun distance. Roughly 150 million kilometres (1.49598×10^8km). The AU is used mainly when discussing the solar system - for example the distance of various planets from the Sun.

Light year A light year is not, as some people believe, a measure of time. It is the distance that light travels in a year. The speed of light being approximately 300,000 kilometres per second means a light year is a very large distance indeed, working out at about 9.5 trillion kilometres (9.46073×10^{12} km). Light years are most frequently used when describing the distance of stars and galaxies or the sizes of large-scale objects like galaxies, nebulae etc.

Parsec A parsec is defined as the distance of an object that has an annual parallax of 1 second of arc. This equates to 3.26156 light years (3.08568×10^{13} km). Parsecs are most frequently used when describing the distance of stars or the sizes of large-scale objects like galaxies, nebulae etc.

G.3.2 Time

The length of a day is defined as the amount of time that it takes for the Sun to travel from the highest point in the sky at mid-day to the next high-point on the next day. In astronomy this is called a *solar day*. The apparent motion of the Sun is caused by the rotation of the Earth. However, in this time, the Earth not only spins, it also moves slightly round it's orbit. Thus in one solar day the Earth does not spin exactly 360° on it's axis. Another way to measure day length is to consider how long it takes for the Earth to rotate exactly 360°. This is known as one *sidereal day*.

Figure **??** illustrates the motion of the Earth as seen looking down on the Earth orbiting the Sun.. The red triangle on the Earth represents the location of an observer. The figure shows the Earth at four times:

1 The Sun is directly overhead - it is mid-day.

2 Twelve hours have passed since 1. The Earth has rotated round and the observer is on the opposite side of the Earth from the Sun. It is mid-night. The Earth has also moved round in it's orbit a little.

3 The Earth has rotated exactly 360°. Exactly one sidereal day has passed since 1.

4 It is mid-day again - exactly one solar day since 1. Note that the Earth has rotated more than 360° since 1.

It should be noted that in figure **??** the sizes of the Sun and Earth and not to scale. More importantly, the distance the Earth moves around it's orbit is much exaggerated. In one real solar day, the Earth takes a year to travel round the Sun - $365\frac{1}{4}$ solar days. The length of a sidereal day is about 23 hours, 56 minutes and 4 seconds.

It takes exactly one sidereal day for the celestial sphere to make one revolution in the sky. Astronomers find sidereal time useful when observing. When visiting observatories, look out for doctored alarm clocks that have been set to run in sidereal time!

G.3.3 Angles

Astronomers typically use degrees to measure angles. Since many observations require very precise measurement, the degree is subdivided into sixty *minutes of arc* also known as *arc-minutes*. Each minute of arc is further subdivided into sixty *seconds of arc*, or *arc-seconds*. Thus one degree is equal to 3600 seconds of arc. Finer grades of precision are usually expressed using the SI prefixes with arc-seconds, e.g. *milli arc-seconds* (one milli arc-second is one thousandth of an arc-second).

G.3.3.1 Notation

Degrees are denoted using the ° symbol after a number. Minutes of arc are denoted with a ’, and seconds of arc are denoted using ”. Angles are frequently given in two formats:

1. DMS format—degrees, minutes and seconds. For example 90°*15’12”*. When more precision is required, the seconds component may include a decimal part, for example 90°*15’12.432”* .

2. Decimal degrees, for example 90.2533°

G.3.4 The Magnitude Scale

When astronomers talk about magnitude, they are referring to the brightness of an object. How bright an object appears to be depends on how much light it's giving out and how far it is from the observer. Astronomers separate these factors by using two measures: *absolute magnitude (M)* which is a measure of how much light is being given out by an object, and *apparent magnitude (m)* which is how bright something appears to be in the sky.

For example, consider two 100 watt lamps, one which is a few meters away, and one which is a kilometre away. Both give out the same amount of light - they have the same absolute magnitude. However the nearby lamp seems much brighter - it has a much greater apparent magnitude. When astronomers talk about magnitude without specifying whether

Object	*m*	*M*
The Sun	-27	4.8
Vega	0.05	0.6
Betelgeuse	0.47	-7.2
Sirius (the brightest star)	-1.5	1.4
Venus (at brightest)	-4.4	-
Full Moon (at brightest)	-12.6	-

they mean apparent or absolute magnitude, they are usually referring to apparent magnitude.

The magnitude scale has its roots in antiquity. The Greek astronomer Hipparchus defined the brightest stars in the sky to be *first magnitude*, and the dimmest visible to the naked eye to be *sixth magnitude*. In the 19th century British astronomer Norman Pogson quantified the scale more precisely, defining it as a logarithmic scale where a magnitude 1 object is 100 times as bright as a magnitude 6 object (a difference of five magnitudes). The zero-point of the modern scale was originally defined as the brightness of the star Vega, however this was re-defined more formally in 1982[2]. Objects brighter than Vega are given negative magnitudes.

The absolute magnitude of a star is defined as the magnitude a star would appear if it were 10 parsecs from the observer.

Table **??** lists several objects that may be seen in the sky, their apparent magnitude and their absolute magnitude where applicable (only stars have an absolute magnitude value. The planets and the Moon don't give out light like a star does - they reflect the light from the Sun).

G.3.5 Luminosity

Luminosity is an expression of the total energy radiated by a star. It may be measured in watts, however, astronomers tend to use another expression—*solar luminosities* where an object with twice the Sun's luminosity is considered to have two solar luminosities and so on. Luminosity is related to absolute magnitude.

G.4 Precession

As the Earth orbits the Sun throughout the year, the axis of rotation (the line running through the [rotational] poles of the Earth) seems to point towards the same position on the celestial sphere, as can be seen in figure G.1. The angle between the axis of rotation and the perpendicular of the orbital plane is called the *obliquity of the ecliptic*. It is 23° 27'.

Observed over very long periods of time the direction the axis of rotation points does actually change. The angle between the axis of rotation and the orbital plane stays constant, but the direction the axis points—the position of the celestial pole transcribes a circle on the stars in the celestial sphere. This process is called *precession*. The motion is similar to the way in which a gyroscope slowly twists as figure **??** illustrates.

Precession is a slow process. The axis of rotation twists through a full 360° about once every 28,000 years.

Precession has some important implications:

1. RA/Dec coordinates change over time, albeit slowly. Measurements of the positions of stars recorded using RA/Dec coordinates must also include a date for those coordinates.

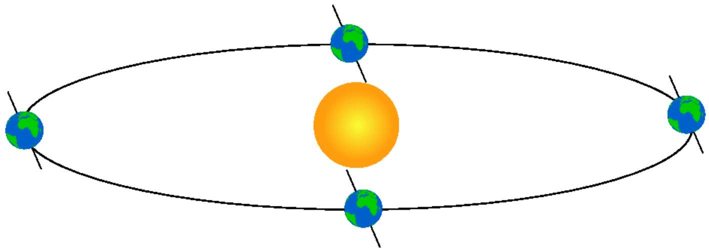


Figure G.1: Obliquity of the Ecliptic

2. Polaris, the pole star won't stay a good indicator of the location of the Northern celestial pole. In 14,000 years time Polaris will be nearly 47° away from the celestial pole!

G.5 Parallax

Parallax is the change of angular position of two stationary points relative to each other as seen by an observer, due to the motion of said observer. Or more simply put, it is the apparent shift of an object against a background due to a change in observer position.

This can be demonstrated by holding ones thumb up at arm's length. Closing one eye, note the position of the thumb against the background. After swapping which eye is open (without moving), the thumb appears to be in a different position against the background.

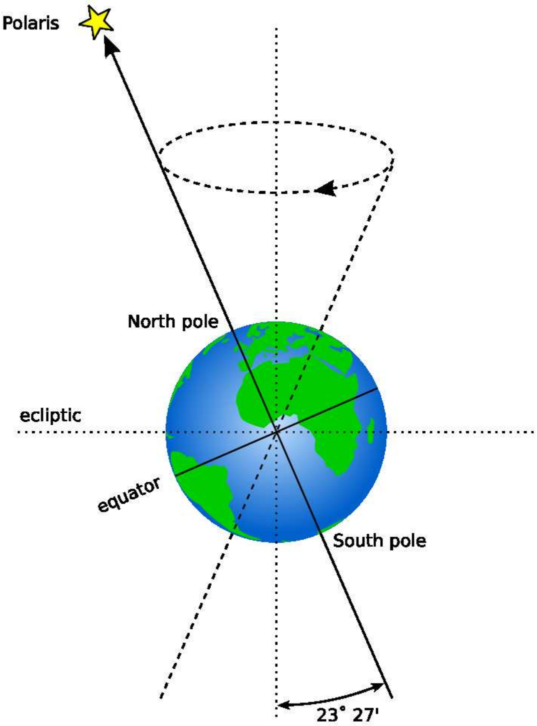
A similar thing happens due to the Earth's motion around the Sun. Nearby stars appear to move against more distant background stars, as illustrated in figure **??**. The movement of nearby stars against the background is called *stellar parallax*, or *annual parallax*.

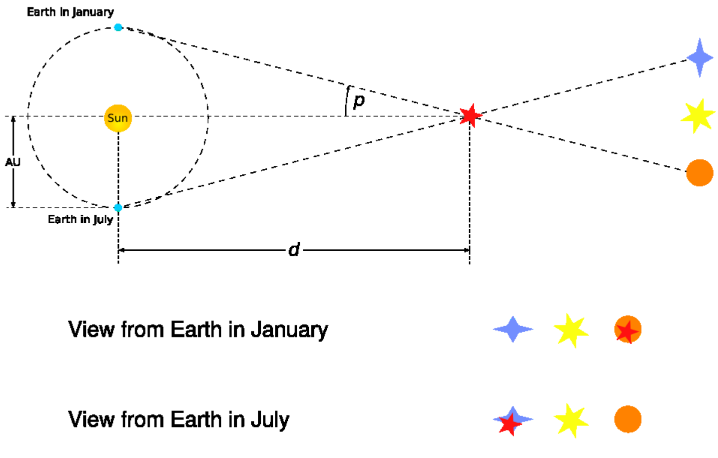
Since we know the distance the radius of the Earth's orbit around the Sun from other methods, we can use simple geometry to calculate the distance of the nearby star if we measure annual parallax.

In figure **??** the annual parallax p is half the angular distance between the apparent positions of the nearby star. The distance of the nearby object is d. Astronomers use a unit of distance called the parsec which is defined as the distance at which a nearby star has $p = 1''$.

Even the nearest stars exhibit very small movement due to parallax. The closest star to the Earth other than the Sun is Proxima Centuri. It has an annual parallax of 0.77199", corresponding to a distance of 1.295 parsecs (4.22 light years).

Even with the most sensitive instruments for measuring the positions of the stars it is only possible to use parallax to determine the distance of stars up to about 1,600 light years from the Earth, after which the annual parallax is so small it cannot be measured accurately enough.


Polaris
North pole
ecliptic
equator
South pole
23° 27'


Earth in January
Sun
p
AU
Earth in July
d
View from Earth in January
View from Earth in July

G.6 Proper Motion

Proper motion is the change in the position of a star over time as a result of it's motion through space relative to the Sun. It does not include the apparent shift in position of star due to annular parallax. The star exhibiting the greatest proper motion is Barnard's Star which moves more then ten seconds of arc per year.

Appendix H

Astronomical Phenomena

This chapter focuses on the observational side of astronomy—what we see when we look at the sky.

H.1 The Sun

Without a doubt, the most prominent object in the sky is the Sun. The Sun is so bright that when it is in the sky, it's light is scattered by the atmosphere to such an extent that almost all other objects in the sky are rendered invisible.

The Sun is a star like many others but it is much closer to the Earth at approximately 150 million kilometres. The next nearest star, Proxima Centuri is approximately 260,000 times further away from us than the Sun! The Sun is also known as *Sol*, it's Latin name.

Over the course of a year, the Sun appears to move round the celestial sphere in a great circle known as the *ecliptic*. Stellarium can draw the ecliptic on the sky. To toggle drawing of the ecliptic, press the `4` or `,` key.

WARNING: Looking at the Sun can permanently damage the eye. Never look at the Sun without using the proper filters! By far the safest way to observe the Sun it to look at it on a computer screen, courtesy of Stellarium!

H.2 Stars

The Sun is just one of billions of stars. Even though many stars have a much greater absolute magnitude than the Sun (the give out more light), they have an enormously smaller apparent magnitude due to their large distance. Stars have a variety of forms—different sizes, brightnesses, temperatures, and colours. Measuring the position, distance and attributes of the stars is known as *astrometry*, and is a major part of observational astronomy.

H.2.1 Multiple Star Systems.

Many stars have a stellar companions. As many as six stars can be found orbiting one-another in close association. Such associations are known a *multiple star systems*—*binary systems* being the most common with two stars. Multiple star systems are more common than solitary stars, putting our Sun in the minority group.

Sometimes multiple stars orbit one-another in a way that means one will periodically eclipse the other. These *eclipsing binaries* or *Algol variables*

H.2.2 Optical Doubles & Optical Multiples

Sometimes two or more stars appear to be very close to one another in the sky, but in fact have great separation, being aligned from the point of view of the observer but of different distances. Such pairings are known as *optical doubles* and *optical multiples*.

H.2.3 Constellations

The constellations are groupings of stars that are visually close to one another in the sky. The actual groupings are fairly arbitrary—different cultures have group stars together into different constellations. In many cultures, the various constellations have been associated with mythological entities. As such people have often projected pictures into the skies as can be seen in figure **??** which shows the constellation of Ursa Major. On the left is a picture with the image of the mythical Great Bear, on the right only a line-art version is shown. The seven bright stars of Ursa Major are widely recognised, known variously as "the plough", the "pan-handle", and the "big dipper". This sub-grouping is known as an *asterism*—a distinct grouping of stars. On the right, the picture of the bear has been removed and only a constellation diagram remains.

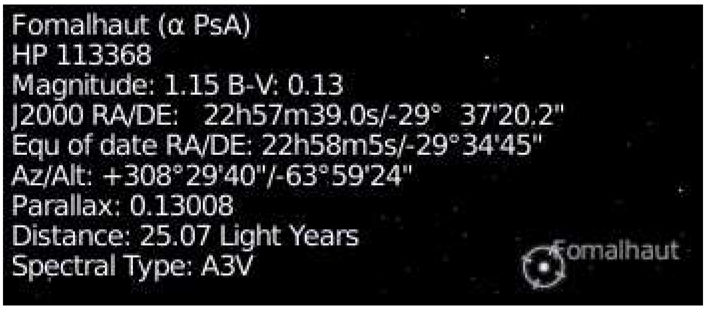
Stellarium can draw both constellation diagrams and artistic representations of the constellations. Multiple sky cultures are supported: Western, Polynesian, Egyptian and Chinese constellations are available, although at time of writing the non-Western constellations are not complete, and as yet there are no artistic representations of these sky-cultures.[1].

Aside from historical and mythological value, to the modern astronomer the constellations provide a way to segment the sky for the purposes of describing locations of objects, indeed one of the first tasks for an amateur observer is *learning the constellations*—the process of becoming familiar with the relative positions of the constellations, at what time of year a constellation is visible, and in which constellations observationally interesting objects reside. Internationally, astronomers have adopted the Western (Greek/Roman) constellations as a common system for segmenting the sky. As such some formalisation has been adopted, each constellation having a *proper name*, which is in Latin, and a three letter abbreviation of that name. For example, Ursa Major has the abbreviation UMa.

H.2.4 Star Names

Stars can have many names. The brighter stars often have *common names* relating to mythical characters from the various traditions. For example the brightest star in the sky, Sirius is also known as The Dog Star (the name Canis Major—the constellation Sirius is found in—is Latin for "The Great Dog").

[1] Contributions of artwork for these sky cultures would be very welcome - post in the forums if you can help!



There are several more formal naming conventions that are in common use.

H.2.4.1 Bayer Designation

German astronomer *Johan Bayer* devised one such system in the 16-17th century. His scheme names the stars according to the constellation in which they lie prefixed by a lower case Greek letter, starting at α for the brightest star in the constellation and proceeding with β, γ, ... in descending order of apparent magnitude. For example, such a *Bayer Designation* for Sirius is "α Canis Majoris" (note that the genitive form of the constellation name is used). There are some exceptions to the descending magnitude ordering, and some multiple stars (both real and optical) are named with a numerical superscript after the Greek letter, e.g.π^1... π^6 Orionis.

H.2.4.2 Flamsteed Designation

English astronomer *John Flamsteed* numbered stars in each constellation in order of increasing right ascension followed by the form of the constellation name, for example "61 Cygni".

H.2.4.3 Catalogues

As described in section H.11, various star catalogues assign numbers to stars, which are often used in addition to other names. Stellarium gets it's star data from the Hipparcos catalogue, and as such stars in Stellarium are generally referred to with their Hipparcos number, e.g. "HP 62223". Figure **??** shows the information Stellarium displays when a star is selected. At the top, the common name and Flamsteed designation are shown, followed by the RA/Dec coordinates, apparent magnitude, distance and Hipparcos number.

H.2.5 Spectral Type & Luminosity Class

Stars have many different colours. Seen with the naked eye most appear to be white, but this is due to the response of the eye—at low light levels the eye is not sensitive to colour. Typically the unaided eye can start to see differences in colour only for stars that have apparent magnitude brighter than 1. Betelgeuse, for example has a distinctly red tinge to it, and Sirius appears to be blue[2].

By splitting the light from a star using a prism attached to a telescope and measuring the relative intensities of the colours of light the star emits—the *spectra*—a great deal of interesting information can be discovered about a star including its surface temperature,

[2] Thousands of years ago Sirius was reported in many account to have a red tinge to it—a good explanation for this has yet to be found.

and the presence of various elements in its atmosphere.

Spectral Type	Surface Temperature (°K)	Star Colour
O	28,000—50,000	Blue
B	10,000—28,000	Blue-white
A	7,500—10,000	White-blue
F	6,000—7,500	Yellow-white
G	4,900—6,000	Yellow
K	3,500—4,900	Orange
M	2,000—3,500	Red

Astronomers groups stars with similar spectra into *spectral types*, denoted by one of the following letters: O, B, A, F, G, K and M[3]. Type O stars have a high surface temperature (up to around 50,000°K) while the at other end of the scale, the M stars are red and have a much cooler surface temperature, typically 3000°K. The Sun is a type G star with a surface temperature of around 5,500°K. Spectral types may be further sub-divided using a numerical suffixes ranging from 0-9 where 0 is the hottest and 9 is the coolest. Table **??** shows the details of the various spectral types.

For about 90% of stars, the absolute magnitude increases as the spectral type tends to the O (hot) end of the scale. Thus the whiter, hotter stars tend to have a greater luminosity. These stars are called *main sequence* stars. There are however a number of stars that have spectral type at the M end of the scale, and yet they have a high absolute magnitude. These stars have a very large size, and consequently are known as *giants*, the largest of these known as *super-giants.*

There are also stars whose absolute magnitude is very low regardless of the spectral class. These are known as *dwarf stars*, among them *white dwarfs* and *brown dwarfs*.

A *luminosity class* is an indication of the type of star—whether it is main sequence, a giant or a dwarf. Luminosity classes are denoted by a number in roman numerals, as described in table **??**.

Luminosity class	Description
Ia, Ib	Super-giants
II	Bright giants
III	Normal giants
IV	Sub-giants
V	Main sequence
VI	Sub-dwarfs
VII	White-dwarfs

Plotting the luminosity of stars against their spectral type/surface temperature, gives a diagram called a Hertzsprung-Russell diagram (after the two astronomers *Ejnar Hertzsprung* and *Henry Norris Russell* who devised it). A slight variation of this is see in figure H.1 (which is technically a colour/magnitude plot).

H.2.6 Variables

Most stars are of nearly constant luminosity. The Sun is a good example of one which goes through relatively little variation in brightness (usually about 0.1% over an 11 year solar

[3] A common aide to memory for the letters used in spectral types is the mnemonic "Oh Be A Fine Girl, Kiss Me".

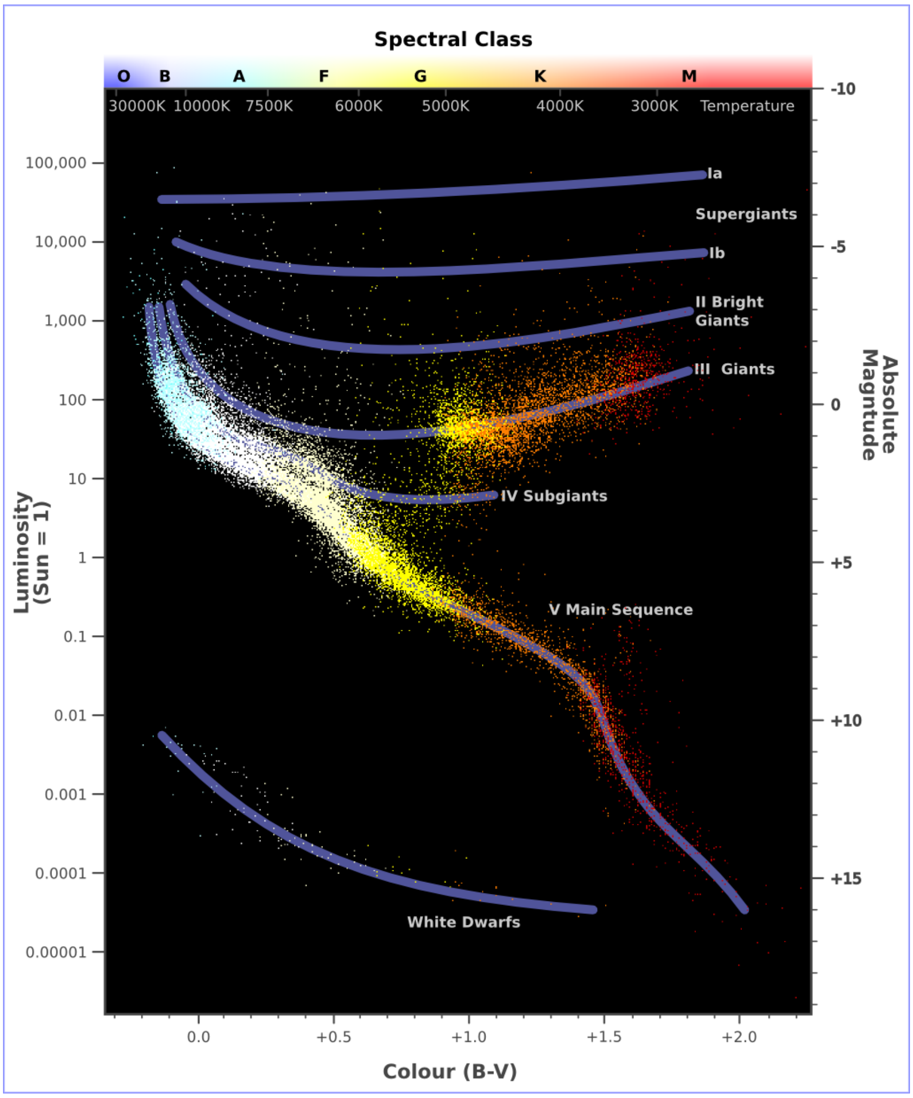


Figure H.1: Plot of star colour vs. magnitude

New Moon	The moon's disc is fully in shadow, or there is just a slither of illuminated surface on the edge.
Waxing Crescent	Less than half the disc is illuminated, but more is illuminated each night.
First Quarter	Approximately half the disc is illuminated, and increasing each night.
Waxing Gibbous	More than half of the disc is illuminated, and still increasing each night.
Full Moon	The whole disc of the moon is illuminated.
Waning Gibbous	More than half of the disc is illuminated, but the amount gets smaller each night.
Last Quarter	Approximately half the disc is illuminated, but this gets less each night.
Waning Crescent	Less than half the disc of the moon is illuminated, and this gets less each night.

cycle). Many stars, however, undergo significant variations in luminosity, and these are known as *variable stars*. There are many types of variable stars falling into two categories *intrinsic* and *extrinsic*.

Intrinsic variables are stars which have intrinsic variations in brightness, that is the star itself gets brighter and dimmer. There are several types of intrinsic variables, probably the best-known and more important of which is the Cepheid variable whose luminosity is related to the period with which it's brightness varies. Since the luminosity (and therefore absolute magnitude) can be calculated, Cepheid variables may be used to determine the distance of the star when the annual parallax is too small to be a reliable guide.

Extrinsic variables are stars of constant brightness that show changes in brightness as seen from the Earth. These include rotating variables, or stars whose apparent brightness change due to rotation, and eclipsing binaries.

H.3 Our Moon

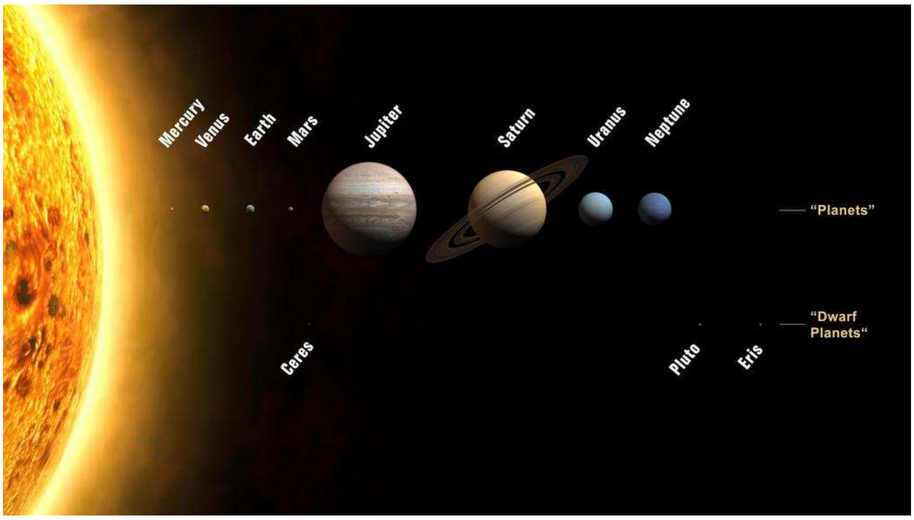
The Moon is the large satellite which orbits the Earth approximately every 28 days. It is seen as a large bright disc in the early night sky that rises later each day and changes shape into a crescent until it disappears near the Sun. After this it rises during the day then gets larger until it again becomes a large bright disc again.

H.3.1 Phases of the Moon

As the moon moves round its orbit, the amount that is illuminated by the sun as seen from a vantage point on Earth changes. The result of this is that approximately once per orbit, the moon's face gradually changes from being totally in shadow to being fully illuminated and back to being in shadow again. This process is divided up into various *phases* as described in table **??**.

H.4 The Major Planets

Unlike the stars whose relative positions remain more or less constant, the planets seem to move across the sky over time (the word "planet" comes from the Greek for "wanderer"). The planets are, like the Earth, massive bodies that are in orbit around the Sun. Until 2006



there was no formal definition of a planet leading to some confusion about the classification for some bodies widely regarded as being planets, but which didn't seem to fit with the others.

> In 2006 the International Astronomical Union defined a planet as a celestial body that, within the Solar System:
>
> > a) is in orbit around the Sun
> >
> > b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape; and
> >
> > c) has cleared the neighbourhood around its orbit
>
> or within another system:
>
> > i) is in orbit around a star or stellar remnants
> >
> > ii) has a mass below the limiting mass for thermonuclear fusion of deuterium; and
> >
> > iii) is above the minimum mass/size requirement for planetary status in the Solar System.

Moving from the Sun outwards, the major planets are: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. Since the formal definition of a planet in 2006 Pluto has been relegated to having the status of *dwarf planet* along with bodies such as Ceres and Eris. See figure **??**.

H.4.1 Terrestrial Planets

The planets closest to the sun are called collectively the *terrestrial* planets. The terrestrial planets are: Mercury, Venus, Earth and Mars.

The terrestrial planets are relatively small, comparatively dense, and have solid rocky surface. Most of their mass is made from solid matter, which is mostly rocky and/or metallic in nature.

H.4.2 Jovian Planets

Jupiter, Saturn, Uranus and Neptune make up the Jovian planets. They are much more massive than the terrestrial planets, and do not have a solid surface. Jupiter is the largest of all the planets with a mass over 300 times that of the Earth!

The Jovian planets do not have a solid surface - the vast majority of their mass being in gaseous form (although they may have rocky or metallic cores). Because of this, they have an average density which is much less than the terrestrial planets. Saturn's mean density is only about $0.7\,g/cm^3$ - it would float in water![4]

H.5 The Minor Planets

As well as the Major Planets, the solar system also contains innumerable smaller bodies in orbit around the Sun. These are generally classed as the *minor planets*, or *planetoids*, and include *asteroids*, and [sometimes?] comets.

H.5.1 Asteroids

Asteroids are celestial bodies orbiting the Sun in more or less regular orbits mostly between Mars and Jupiter. They are generally rocky bodies like the inner (terrestrial) planets, but of much smaller size. There are countless in number ranging in size from about ten meters to thousands of kilometres.

H.5.2 Comets

A comet is a small body in the solar system that orbits the Sun and (at least occasionally) exhibits a coma (or atmosphere) and/or a tail.

Comets have a very eccentric orbit (very elliptical), and as such spend most of their time a very long way from the Sun. Comets are composed of rock, dust and ices. When they come close to the Sun, the heat evaporates the ices, causing a gaseous release. This gas, and loose material which comes away from the body of the comet is swept away from the Sun by the Solar wind, forming the tail.

Comets whose orbit brings them close to the Sun more frequently than every 200 years are considered to be *short period* comets, the most famous of which is probably Comet Halley, named after the British astronomer Edmund Halley, which has an orbital period of roughly 76 years.

H.6 Galaxies

Stars, it seems, are gregarious - they like to live together in groups. These groups are called galaxies. The number of stars in a typical galaxy is literally astronomical - many *billions* - sometimes ever *hundreds of billions* of stars!

Our own star, the sun, is part of a galaxy. When we look up at the night sky, all the stars we can see are in the same galaxy. We call our own galaxy the Milky Way (or sometimes simply "the Galaxy").

Other galaxies appear in the sky as dim fuzzy blobs. Only four are normally visible to the naked eye. The Andromeda galaxy (M31) visible in the Northern hemisphere, the two Magellanic clouds, visible in the Southern hemisphere, and the home galaxy Milky Way, visible in parts from north and south under dark skies.

There are thought to be billions of galaxies in the universe comprised of an unimaginably large number of stars.

The vast majority of galaxies are so far away that they are very dim, and cannot be seen without large telescopes, but there are dozens of galaxies which may be observed in

[4] OK, it's a silly thing to say - gas giants really aren't something you can take down the local swimming pool and throw in the deep end... It's a nice thought though.

medium to large sized amateur instruments. Stellarium includes images of many galaxies, including the Andromeda galaxy (M31), the Pinwheel Galaxy (M101), the Sombrero Galaxy (M104) and many others.

Astronomers classify galaxies according to their appearance. Some classifications include *spiral galaxies*, *elliptical galaxies*, *lenticular galaxies* and *irregular galaxies*.

H.7 The Milky Way

It's a little hard to work out what our galaxy would look like from far away, because when we look up at the night sky, we are seeing it from the inside. All the stars we can see are part of the Milky Way, and we can see them in every direction. However, there is some structure. There is a higher density of stars in particular places.

There is a band of very dense stars running right round the sky in huge irregular stripe. Most of these stars are very dim, but the overall effect is that on very dark clear nights we can see a large, beautiful area of diffuse light in the sky. It is this for which we name our galaxy.

The reason for this effect is that our galaxy is somewhat like a disc, and we are off to one side. Thus when we look towards the centre of the disc, we see more a great concentration of stars (there are more star in that direction). As we look out away from the centre of the disc we see fewer stars - we are staring out into the void between galaxies!

H.8 Nebulae

Seen with the naked eye, binoculars or a small telescope, a *nebula* (plural *nebulae*) are fuzzy patches on the sky. Historically, the term referred to any extended object, but the modern definition excludes some types of object such as galaxies.

Observationally, nebulae are popular objects for amateur astronomers - they exhibit complex structure, spectacular colours and a wide variety of forms. Many nebulae are bright enough to be seen using good binoculars or small to medium sized telescopes, and are a very photogenic subject for astro-photographers.

Nebulae are associated with a variety of phenomena, some being clouds of interstellar dust and gas in the process of collapsing under gravity, some being envelopes of gas thrown off during a supernova event (so called *supernova remnants*), yet others being the remnants of solar systems around dead stars (*planetary nebulae*).

Examples of nebulae for which Stellarium has images include the Crab Nebula (M1), which is a supernova remnant and the Dumbbell Nebula (M27) which is a planetary nebula.

H.9 Meteoroids

These objects are small pieces of space debris left over from the early days of the solar system that orbit the Sun. They come in a variety of shapes, sizes an compositions, ranging from microscopic dust particles up to about ten meters across.

Sometimes these objects collide with the Earth. The closing speed of these collisions is generally extremely high (tens or kilometres per second). When such an object ploughs through the Earth's atmosphere, a large amount of kinetic energy is converted into heat and light, and a visible flash or streak can often be seen with the naked eye. Even the smallest particles can cause these events which are commonly known as *shooting stars*.

While smaller objects tend to burn up in the atmosphere, larger, denser objects can penetrate the atmosphere and strike the surface of the planet, sometimes leaving meteor craters.

Sometimes the angle of the collision means that larger objects pass through the atmosphere but do not strike the Earth. When this happens, spectacular fireballs are sometimes seen.

Meteoroids is the name given to such objects when they are floating in space.

A *Meteor* is the name given to the visible atmospheric phenomenon.

Meteorites is the name given to objects that penetrate the atmosphere and land on the surface.

H.10 Eclipses

Eclipses occur when an apparently large celestial body (planet, moon etc.) moves between the observer (that's you!) and a more distant object - the more distant object being eclipsed by the nearer one.

H.10.1 Solar Eclipses

Solar eclipses occur when our Moon moves between the Earth and the Sun. This happens when the inclined orbit of the Moon causes its path to cross our line of sight to the Sun. In essence it is the observer falling under the shadow of the moon.

There are three types of solar eclipses:

Partial The Moon only covers part of the Sun's surface.

Total The Moon completely obscures the Sun's surface.

Annular The Moon is at aphelion (furthest from Earth in its elliptic orbit) and its disc is too small to completely cover the Sun. In this case most of the Sun's disc is obscured - all except a thin ring around the edge.

H.10.2 Lunar Eclipses

Lunar eclipses occur when the Earth moves between the Sun and the Moon, and the Moon is in the Earth's shadow. They occur under the same basic conditions as the solar eclipse but can occur more often because the Earth's shadow is so much larger than the Moon's.

Total lunar eclipses are more noticeable than partial eclipses because the Moon moves fully into the Earth's shadow and there is very noticeable darkening. However, the Earth's atmosphere refracts light (bends it) in such a way that some sunlight can still fall on the Moon's surface even during total eclipses. In this case there is often a marked reddening of the light as it passes through the atmosphere, and this can make the Moon appear a deep red colour.

H.11 Catalogues

Astronomers have made various catalogues of objects in the heavens. Stellarium makes use of several well known astronomical catalogues.

H.11.1 Hipparcos

Hipparcos (for High Precision Parallax Collecting Satellite) was an astrometry mission of the European Space Agency (ESA) dedicated to the measurement of stellar parallax and the proper motions of stars. The project was named in honour of the Greek astronomer Hipparchus.

Ideas for such a mission dated from 1967, with the mission accepted by ESA in 1980. The satellite was launched by an Ariane 4 on 8 August 1989. The original goal was to place the satellite in a geostationary orbit above the earth, however a booster rocket failure resulted in a highly elliptical orbit from 315 to 22,300 miles altitude. Despite this difficulty, all of the scientific goals were accomplished. Communications were terminated on 15 August 1993.

The program was divided in two parts: the *Hipparcos experiment* whose goal was to measure the five astrometric parameters of some 120,000 stars to a precision of some 2 to 4 milli arc-seconds and the *Tycho experiment*, whose goal was the measurement of the astrometric and two-colour photometric properties of some 400,000 additional stars to a somewhat lower precision.

The final Hipparcos Catalogue (120,000 stars with 1 milli arc-second level astrometry) and the final Tycho Catalogue (more than one million stars with 20-30 milli arc-second astrometry and two-colour photometry) were completed in August 1996. The catalogues were published by ESA in June 1997. The Hipparcos and Tycho data have been used to create the Millennium Star Atlas: an all-sky atlas of one million stars to visual magnitude 11, from the Hipparcos and Tycho Catalogues and 10,000 non-stellar objects included to complement the catalogue data.

There were questions over whether Hipparcos has a systematic error of about 1 milli arc-second in at least some parts of the sky. The value determined by Hipparcos for the distance to the Pleiades is about 10% less than the value obtained by some other methods. By early 2004, the controversy remained unresolved.

Stellarium uses the Hipparcos Catalogue for star data, as well as having traditional names for many of the brighter stars. The stars tab of the search window allows for searching based on a Hipparcos Catalogue number (as well as traditional names), e.g. the star Sadalmelik in the constellation of Aquarius can be found by searching for the name, or it's Hipparcos number, 109074.

H.11.2 The Messier Objects

The *Messier* objects are a set of astronomical objects catalogued by Charles Messier in his catalogue of *Nebulae and Star Clusters* first published in 1774. The original motivation behind the catalogue was that Messier was a comet hunter, and was frustrated by objects which resembled but were not comets. He therefore compiled a list of these objects.

The first edition covered 45 objects numbered M1 to M45. The total list consists of 110 objects, ranging from M1 to M110. The final catalogue was published in 1781 and printed in the *Connaissance des Temps* in 1784. Many of these objects are still known by their Messier number.

Because the Messier list was compiled by astronomers in the Northern Hemisphere, it contains only objects from the north celestial pole to a celestial latitude of about -35°. Many impressive Southern objects, such as the Large and Small Magellanic Clouds are excluded from the list. Because all of the Messier objects are visible with binoculars or small telescopes (under favourable conditions), they are popular viewing objects for amateur astronomers. In early spring, astronomers sometimes gather for "Messier Marathons", when all of the objects can be viewed over a single night.

Stellarium includes images of many Messier objects.

H.12 Observing Hints

When star-gazing, there's a few little things which make a lot of difference, and are worth taking into account.

Dark skies For many people getting away from light pollution isn't an easy thing. At best it means a drive away from the towns, and for many the only chance to see a sky without significant glow from street lighting is on vacation. If you can't get away from the cities easily, make the most of it when you are away.

Wrap up warm The best observing conditions are the same conditions that make for cold nights, even in the summer time. Observing is not a strenuous physical activity, so you will feel the cold a lot more than if you were walking around. Wear a lot of warm clothing, don't sit/lie on the floor (at least use a camping mat... consider taking a deck-chair), and take a flask of hot drink.

Dark adaptation The true majesty of the night sky only becomes apparent when the eye has had time to become accustomed to the dark. This process, known as dark adaptation, can take up to half and hour, and as soon as the observer sees a bright light they must start the process over. Red light doesn't compromise dark adaptation as much as white light, so use a red torch if possible (and one that is as dim as you can manage with). A single red LED light is ideal.

The Moon Unless you're particularly interested in observing the Moon on a given night, it can be a nuisance—it can be so bright as to make observation of dimmer objects such as nebulae impossible. When planning what you want to observe, take the phase and position of the Moon into account. Of course Stellarium is the ideal tool for finding this out!

Averted vision A curious fact about the eye is that it is more sensitive to dim light towards the edge of the field of view. If an object is slightly too dim to see directly, looking slightly off to the side but concentrating on the object's location can often reveal it[5].

Angular distance Learn how to estimate angular distances. Learn the angular distances described in section H.13. If you have a pair of binoculars, find out the angular distance across the field of view[6] and use this as a standard measure.

H.13 Handy Angles

Being able to estimate angular distance can be very useful when trying to find objects from star maps in the sky. One way to do this with a device called a *crossbow*[7].

Crossbows are a nice way get an idea of angular distances, but carrying one about is a little cumbersome. A more convenient alternative is to hold up an object such as a pencil at arm's length. If you know the length of the pencil, d, and the distance of it from your eye, D, you can calculate it's angular size, θ using this formula:

$$\theta = 2 \cdot \arctan(\frac{d}{2D})$$

Another, more handy (ahem!) method is to use the size of your hand at arm's length:

Tip of little finger About 1°

Middle three fingers About 4°

Across the knuckles of the fist About 10°

Open hand About 18°

[5] This curious phenomena is the cause of much childhood anxiety about the dark - shapes and patterns which can be seen out of the corner of the eye disappear when looked at directly!

[6] Most binoculars state the field of view somewhere on the body of the instrument. Failing that, check the documentation (if you have any) or check with the manufacturer.

[7] An astronomical "crossbow" is essentially a stick with a ruler attached to the end. The non-ruler end of the stick is held up to the face and the user sights along the stick towards the object that is being observed. The length of the stick is such that the markings on the ruler are a known angular distance apart (e.g. 1°). The markings on the ruler are often marked with luminescent paint for night-time use. Vanderbilt Universtiy's site has a nice illustration of the design and use of a "crossbow". The ruler is held in a curve by a piece of string, giving a better indication of the reason for the name. The curve is there to make all parts of the ruler perpendicular to the line of sight which improves the accuracy of the device.

Using you hand in this way is not very precise, but it's close enough to give you some way to translate an idea like "Mars will be 45° above the Southeastern horizon at 21:30". Of course, there is variation from person to person, but the variation is compensated for somewhat by the fact that people with long arms tend to have larger hands. In exercise J.2, you will work out your own "handy angles".

Appendix I

Sky Guide

This section lists some astronomical objects that can be located using Stellarium. All of them can be seen with the naked eye or binoculars. Since many astronomical objects have more than one name (often having a 'proper name', a 'common name' and various catalogue numbers), the table lists the name as it appears in Stellarium—use this name when using Stellarium's search function—and any other commonly used names.

The Location Guide column gives brief instructions for finding each object using nearby bright stars or groups of stars when looking at the real sky - a little time spent learning the major constellations visible from your latitude will pay dividends when it comes to locating fainter (and more interesting!) objects. When trying to locate these objects in the night sky, keep in mind that Stellarium displays many stars that are too faint to be visible without optical aid and even bright stars can be dimmed by poor atmospheric conditions and light pollution.

Stellarium Name	*Other Name(s)*	*Type*	*Magnitude*	*Location Guide*	*Description*
Dubhe and Merak	The Pointers	Stars	1.83, 2.36	The two 'rightmost' of the seven stars that form the main shape of 'The Plough' (Ursa Major).	Northern hemisphere observers are very fortunate to have two stars that point towards Polaris which lie very close to the northern celestial pole). Whatever the time of night or season of the year they are always an immediate clue to the location of the pole star.
M31	Messier 31 The Andromeda Galaxy	Spiral Galaxy	3.4	Find the three bright stars that constitute the main part of the constellation of Andromeda. From the middle of these look toward the constellation of Cassiopeia.	M31 is the most distant object visible to the naked eye, and among the few nebulae that can be seen without a telescope or powerful binoculars. Under good conditions it appears as a large fuzzy patch of light. It is a galaxy containing billions of stars whose distance is roughly three million light years from Earth.
The Garnet Star	Mu Cephei	Variable Star	4.25 (Avg.)	Cephius lies 'above' the W-shape of Cassiopeia. The Garnet Star lies slightly to one side of a point half way between 5 Cephei and 21 Cephei.	A 'supergiant' of spectral class M with a strong red colour. Given it's name by Sir William Herschel in the 18th century, the colour is striking in comparison to it's blue-white neighbours.
4 and 5 Lyrae	Epsilon Lyrae	Double Star	4.7	Look near to Vega (Alpha Lyrae), one of the brightest stars in the sky.	In binoculars epsilon Lyrae is resolved into two separate stars. Remarkably each of these is also a double star (although this will only be seen with a telescope) and all four stars form a physical system.

Stellarium Name	*Other Name(s)*	*Type*	*Magnitude*	*Location Guide*	*Description*
M13	Hercules Cluster	Globular Cluster	5.8	Located approximately of the way along a line from 40 to 44 Herculis.	This cluster of hundreds of thousands of mature stars that appears as a circular 'cloud' using the naked eye or binoculars (a large telescope is required to resolve individual stars). Oddly the cluster appears to contain one young star and several areas that are almost devoid of stars.
M45	The Pleiades, The Seven Sisters	Open Cluster	1.2 (Avg.)	Lies a little under halfway between Aldebaran in Taurus and Almaak in Andromeda.	Depending upon conditions, six to 9 of the blueish stars in this famous cluster will be visible to someone with average eyesight and in binoculars it is a glorious sight. The cluster has more than 500 members in total, many of which are shown to be surrounded by nebulous material in long exposure photographs.
Algol	The Demon Star, Beta Persei	Variable Star	3.0 (Avg.)	Halfway between Aldebaran in Taurus and the middle star of the 'W' of Cassiopeia.	Once every three days or so Algol's brightness changes from 2.1 to 3.4 and back within a matter of hours. The reason for this change is that Algol has a dimmer giant companion star, with an orbital period of about 2.8 days, that causes a regular partial eclipse. Although Algol's fluctuations in magnitude have been known since at least the 17th century it was the first to be proved to be due to an eclipsing companion - it is therefore the prototype Eclipsing Variable.
Sirius	Alpha Canis Majoris	Star	-1.47	Sirius is easily found by following the line of three stars in Orion's belt southwards.	Sirius is a white dwarf star at a comparatively close 8.6 light years. This proximity and it's high innate luminance makes it the brightest star in our sky. Sirius is a double star; it's companion is much dimmer but very hot and is believed to be smaller than the earth.
M44	The Beehive, Praesepe	Open Cluster	3.7	Cancer lies about halfway between the twins (Castor & Pollux) in Gemini and Regulus, the brightest star in Leo. The Beehive can be found between Asellus Borealis and Asellus Australis.	There are probably 350 or so stars in this cluster although it appears to the naked eye simply as a misty patch. It contains a mixture of stars from red giants to white dwarf and is estimated to be some 700 million years old.
27 Cephei	Delta Cephei	Variable Star	4.0 (Avg.)	Locate the four stars that form the square of Cepheus. One corner of the square has two other bright stars nearby forming a distinctive triangle - delta is at the head of this triangle in the direction of Cassiopeia.	Delta Cephei gives it's name to a whole class of variables, all of which are pulsating high-mass stars in the later stages of their evolution. Delta Cephei is also a double star with a companion of magnitude 6.3 visible in binoculars.

Stellarium Name	*Other Name(s)*	*Type*	*Magnitude*	*Location Guide*	*Description*
M42	Orion Nebula	Nebula	4	Almost in the middle of the area bounded by Orion's belt and the stars Saiph and Rigel.	The Orion Nebula is the brightest nebula visible in the night sky and lies at about 1,500 light years from earth. It is a truly gigantic gas and dust cloud that extends for several hundred light years, reaching almost halfway across the constellation of Orion. The nebula contains a cluster of hot young stars known as the Trapezium and more stars are believed to be forming within the cloud.
HP 62223	La Superba, Y Canum Venaticorum	Star	5.5 (Avg.)	Forms a neat triangle with Phad and Alkaid in Ursa Major.	La Superba is a 'Carbon Star' - a group of relatively cool gigantic (usually variable) stars that have an outer shell containing high levels of carbon. This shell is very efficient at absorbing short wavelength blue light, giving carbon stars a distinctive red or orange tint.
52 & 53 Bootis	Nu Bootis 1 & 2	Double Star	5.02, 5.02	Follow a line from Seginus to Nekkar and then continue for the same distance again to arrive at this double star.	This pair are of different spectral type and 52 Bootis, at approximately 800 light years, is twice as far away as 53.

Appendix J

Exercises

J.1 Find M31 in Binoculars

M31—the Andromeda Galaxy—is the most distant object visible to the naked eye. Finding it in binoculars is a rewarding experience for new-comers to observing.

J.1.1 Simulation

1. Set the location to a mid-Northern latitude if necessary (M31 isn't visible for Southern hemisphere observers). The UK is ideal.

2. Find M31 and set the time so that the sky is dark enough to see it. The best time of year for this at Northern latitudes is Autumn/Winter, although there should be a chance to see it at some time of night throughout the year.

3. Set the field of view to 6° (or the field of view of your binoculars if they're different. 6° is typical for 7x50 bins).

4. Practise finding M31 from the bright stars in Cassiopeia and the constellation of Andromeda.

J.1.2 For Real

This part is not going to be possible for many people. First, you need a good night and a dark sky. In urban areas with a lot of light pollution, it's going to be very hard to see Andromeda.

J.2 Handy Angles

As described in section H.13, your hand at arm's length provides a few useful estimates for angular size. It's useful to know if your handy angles are typical, and if not, what they are. The method here below is just one way to do it—feel free to use another method of your own construction!

Hold your hand at arm's length with your hand open—the tips of your thumb and little finger as far apart as you can comfortably hold them. Get a friend to measure the distance between your thumb and your eye, we'll call this D. There is a tendency to over-stretch the arm when someone is measuring it—try to keep the thumb-eye distance as it would be if you were looking at some distant object.

Without changing the shape of your hand, measure the distance between the tips of your thumb and little finger. It's probably easiest to mark their positions on a piece of paper and measure the distance between the marks, we'll call this d. Using some simple trigonometry, we can estimate the angular distance θ:

Repeat the process for the distance across a closed fist, three fingers and the tip of the little finger.

For example, for the author $D = 72$ cm, $d = 21$ cm, so:

$$\begin{aligned} \theta &= 2 \cdot \arctan(\frac{21}{144}) \\ \theta &\approx 16\frac{1}{2}^{\circ} \end{aligned}$$

Remember that handy angles are not very precise—depending on your posture at a given time the values may vary by a fair bit.

J.3 Find a Lunar Eclipse

Stellarium comes with two scripts for finding lunar eclipses, but can you find one on a different date?

J.4 Find a Solar Eclipse

Find a Solar Eclipse using Stellarium & take a screenshot of it.

J.5 Script a Messier Tour

Write a script which shows a tour of five of your favourite messier objects.

1. Make a list of five objects to include in your tour.
2. Close Stellarium and create a new script file in the `<user directory>/scripts/` directory. Call it something ending in `.sts`, for example `mytour.sts`.
3. Put your scripting commands in the file. You should use a regular text editor to edit it, e.g. Notepad.
4. Start Stellarium and run your script.

Hints and tips:

- You can record actions which you perform in Stellarium using the `CTRL-r` key.
- Change the main configuration file so that Stellarium runs in windowed mode - this way you can edit your script in another window without having to shut down Stellarium.
- Enable the script bar to try out commands before adding them to your script.

Appendix K

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Appendix L

Acknowledgements

Primary author	Matthew Gates <matthew@porpoisehead.net>
Sky guide; exercise ideas	Paul Robinson <probinson[at]directspecs[dot]co[dot]uk>
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Mac platform specifics	Rudy Gobits <R.Gobits[at]xs4all[dot]nl>, Dirk Schwarzhans <mei-mail[at]gmx[dot]de>
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