Imaging with *SPIRIT*
Exposure Guide

SPIRIT optical telescopes utilise extremely sensitive cameras to record the light from distant astronomical objects. Even so, exposures of several seconds up to a few minutes are necessary to reveal detail in faint targets.

Several factors influence the exposure length required to image astronomical objects with *SPIRIT*:

- the type of target (e.g. star versus nebulae)
- the brightness or *magnitude* of a target
- target position in the sky
- atmospheric sky conditions and moon phase

Point source objects

Point source objects such as stars and planets are best imaged using exposures of less than 10 seconds. Bright stars and planets, such as Sirius and Jupiter, are so luminous that exposures of less than a second are required to avoid an effect known as 'blooming'.

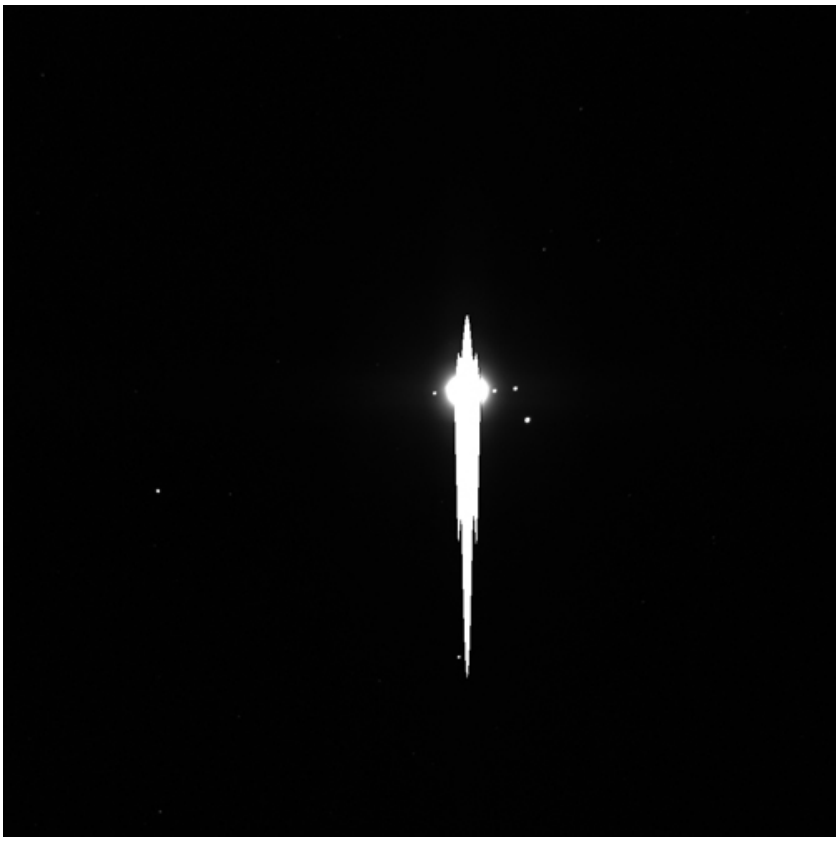

Figure 1: An over-exposed image of Saturn and its moons showing vertical blooming in adjacent pixels.

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Using a red or blue filter can also help with very bright objects by reducing the amount of light that reaches the CCD sensor.

Figure 2: A 0.1 second exposure of Jupiter and its moons using the red filter.

Deep sky objects

Deep sky objects include galaxies and nebulae. The brightest can be imaged with exposures starting at 30 seconds. A good rule of thumb for bright extended nebulae is 30 - 60 seconds.

Figure 3: A 30 second image of the Orion Nebula (M 42).

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Globular clusters are a unique type of deep sky object. Because they are made up of stars (point sources), most can be imaged with exposures shorter than those used for nebulae and galaxies. Bright globular clusters, such as NGC 5139, can be imaged with exposures less than 30 seconds.

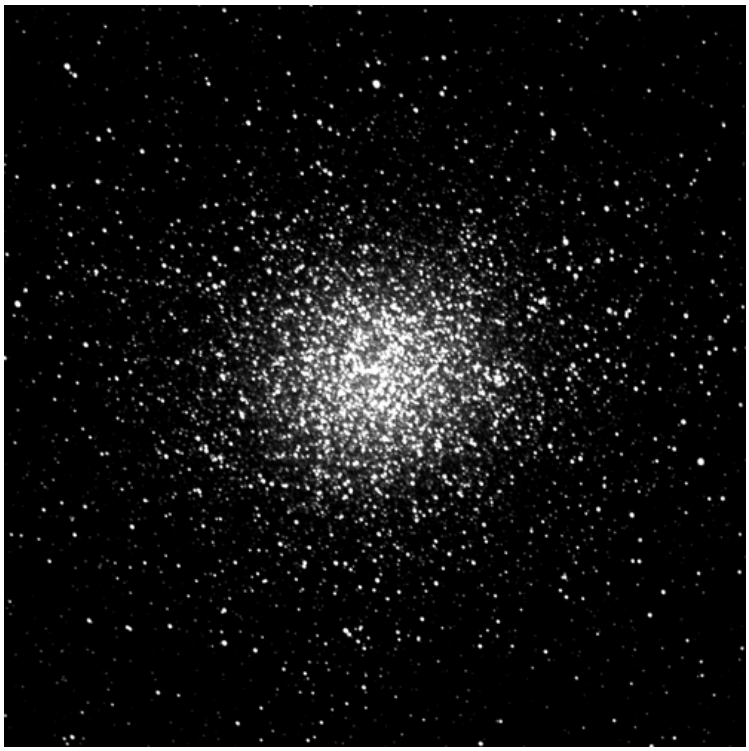

Figure 4: A 15 second image of Omega Centauri (NGC 5139).

These basic exposure rules become less predictable with increasingly faint deep sky objects. An understanding of the magnitude scale can help when planning faint targets.

Magnitude and Stellarium

Brightness or *magnitude* is described using a numerical scale where increasing values represent fainter magnitudes.

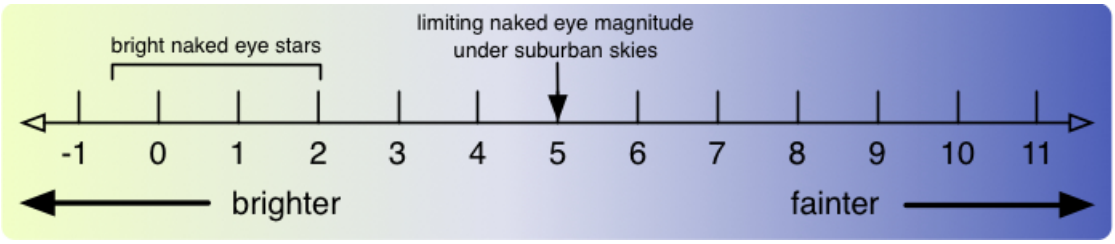

Figure 5: The stellar magnitude scale.

The magnitude scale is logarithmic, using a ratio of 2.512. A magnitude 6 star is approximately 2.5 times fainter than a magnitude 5 star. A magnitude 10 star is 100 times fainter than a magnitude 6 star, and so on.

Planetarium programs such as Stellarium[1] include values of magnitude for most objects. These can be used to provide a starting point when establishing a suitable exposure:

- objects brighter than magnitude 7 can be imaged using exposures of a few seconds;
- objects fainter than magnitude 7 are best imaged using exposures upwards of 10 seconds.

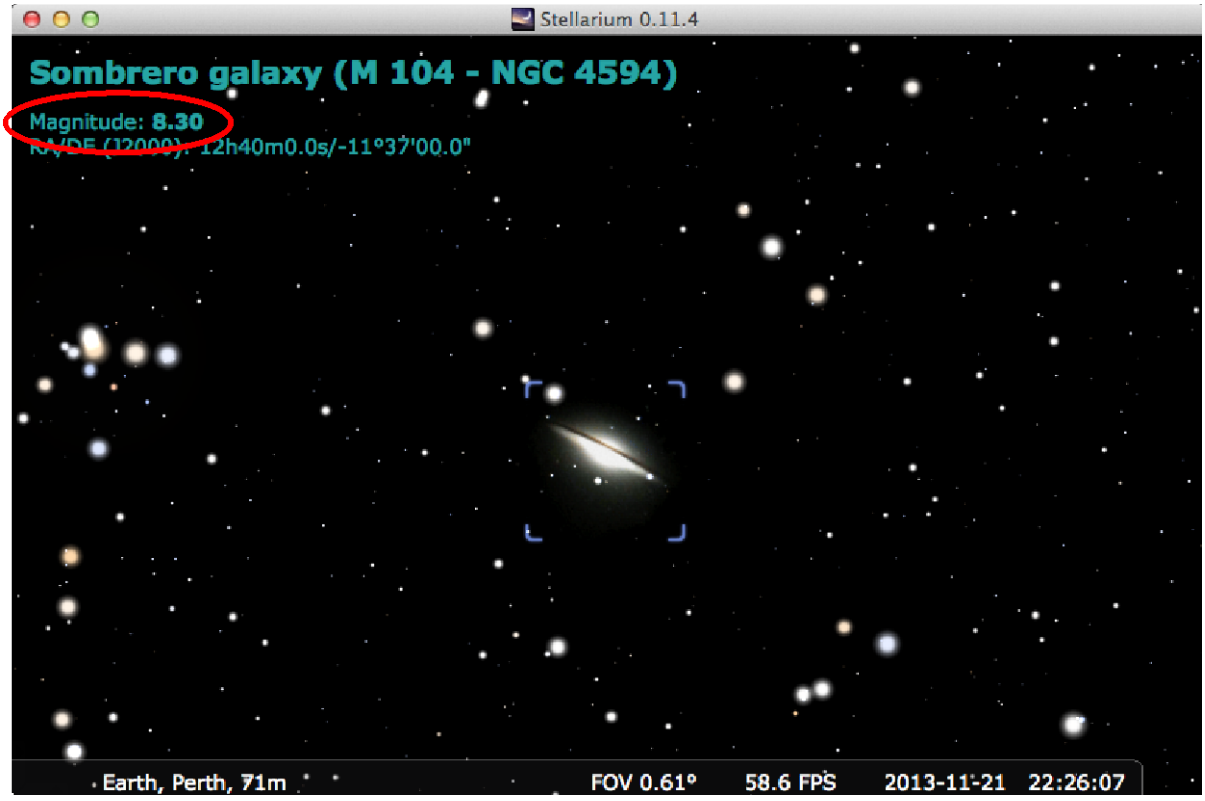

Figure 6: Magnitude displayed when an object is selected in Stellarium.

Diffuse objects such as galaxies and nebulae benefit from longer exposures regardless of their average surface brightness, to bring out the structure and detail in faint areas.

In general, objects with a magnitude brighter than 14 are considered 'bright' targets for *SPIRIT,* and are typically imaged with exposures less than 60 seconds.

Targets with a magnitude fainter than 18.5 are considered challenging under the skies of Perth using telescopes such as *SPIRIT,* with many requiring exposures exceeding 90 seconds under very good seeing conditions.

[1] Stellarium is free planetarium software available from http://stellarium.org/

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The table below provides a starting point of exposures for imaging a variety of common object types with *SPIRIT*.

Object	Type	Exposure (seconds)
Jupiter (and its moons)	very bright planet*	0.1 - 1
Alpha Centauri	bright binary star	0.5 - 1
Uranus	faint planet	5 - 10 (to show satellites)
NGC 5139	large bright globular cluster	10 - 30
NGC 6235	small faint globular cluster	30 - 60
NGC 4755	bright open cluster	15 - 45
M 42	bright nebulae	30 - 45
M 20	faint nebulae	60 - 90
M 104	bright small galaxy	45 - 60
NGC 2997	small diffuse galaxy	60 - 120
1196 Sheba	main belt asteroid	60 (for magnitudes < 18)

** May also benefit from a red or blue filter.*

Target position in the sky

Images of targets that are low in the sky (less than 40 degrees above the horizon) suffer from atmospheric effects, including light pollution. Whenever possible, plan deep sky imaging with targets that are high in the sky or slightly west of the meridian[2].

Optimising long exposures

Exposures of deep sky objects exceeding 60 seconds present additional challenges. Such targets should always be imaged when they are high in the sky on a relatively moonless night.

Good seeing conditions will improve the quality of all images, particularly those of faint diffuse objects. While it is possible to take images lasting many minutes, sky conditions need to be very good in order to make the most of long exposures.

The sky glow caused by light pollution can begin to affect images longer than 2 or 3 minutes in length.

[2] For detailed information on *SPIRIT* target planning, refer to the *SPIRIT* Stellarium Handbook, available at http://spirit.icrar.org/guides-and-documents/

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Figure 7: M 83 is a bright magnitude 7.6 spiral galaxy easily captured by *SPIRIT* with an exposure of 60 seconds.