Understanding Astronomical Filters

Part II: How To Use Them

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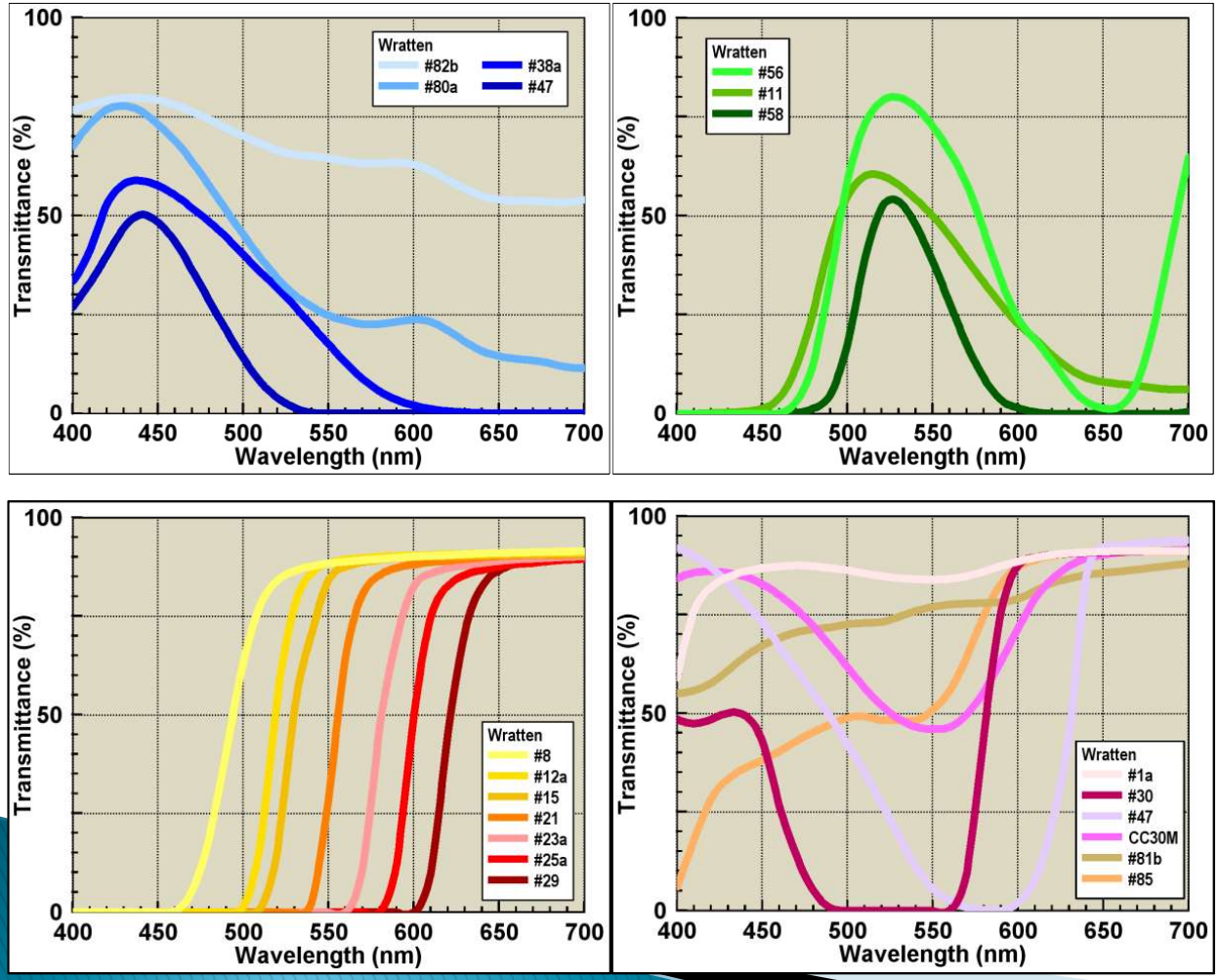
Overview

3 ~~Two~~-Part Filter Series…

- Part I: What Are They
  - What do they do
  - Different types
  - How they work
  - Nomenclature
- Part II: How To Use Them
  - Enhancing solar system observing
  - Controlling light pollution
  - Suggestions & things to remember

Part III: Special Filters

Solar System Observing



- Use filters to darken some features but not others
- Primarily using colour (absorption) type
- Filter choice very subjective:
  - A lot of trial-and-error req'd
  - Personal preference

Planetary Filters – The Long…

Object	Features	Recommended Filter
Mercury	Planet/Sky Contrast	#23A Light Red
	Features	#25 Red #29 Deep Red
Venus	Clouds	#38A Deep Blue #47 Violet #58 Green
	Planet/Sky Contrast	#25 Red #29 Deep Red
	Terminator	#25 Red #29 Deep Red
Moon	Detail	#56 Light Green
	Feature Contrast	#8 Light Yellow #12 Yellow #15 Deep Yellow #80A Blue
	Low Contrast Features	#82A Light Blue
	Glare Reduction	ND13 Neutral Density Variable Polarizer
Mars	Clouds	#15 Deep Yellow
	Maria	#8 Light Yellow #15 Deep Yellow #11 Yellow-Green #21 Orange
		#23A Light Red #25 Red #29 Deep Red
	Blue-Green Areas	#12 Yellow #23A Light Red
	Dust Storms	#38A Deep Blue #56 Light Green
	Polar Caps	#15 Deep Yellow #25 Red #29 Deep Red #47 Violet #56 Light Green #58 Green Deep Sky Filter
	Low Contrast Features	#82A Light Blue
Jupiter	Clouds	#11 Yellow-Green
	Belts	#8 Light Yellow #15 Deep Yellow #21 Orange #23A Light Red #25 Red #29 Deep Red #38A Deep Blue #56 Light Green #80A Blue
	Rilles	#80A Blue
	Festoons	#80A Blue
	Atmosphere	#56 Light Green
	Red-Orange Features	#12 Yellow
	Orange-Red Zonal	#8 Light Yellow
	Red/Blue Contrast	#11 Yellow-Green
	Blue/Light Contrast	#25 Red
	Great Red Spot	#38A Deep Blue #80A Blue
	Galilean Moon Transits	#25 Red #29 Deep Red
	Red/Blue/Light Contrast	#56 Light Green #58 Green
	Polar Regions	#21 Orange #23A Light Red
	Disc	#38A Deep Blue
	Low Contrast Features	#82A Light Blue
Saturn	Clouds	#11 Yellow-Green #12 Yellow #25 Red #29 Deep Red
	Belts	#15 Deep Yellow #21 Orange #23A Light Red #38A Deep Blue #58 Green
		#80A Blue
	Polar regions	#21 Orange #23A Light Red #58 Green #80A Blue
	Rings	#47 Violet
	Cassini Division	#11 Yellow-Green
	Red/Blue Contrast	#11 Yellow-Green
	Red/Orange Features	#12 Yellow
	Low Contrast Features	#82A Light Blue
Uranus	Dusky detail	#8 Light Yellow #15 Deep Yellow
Neptune	Dusky detail	#8 Light Yellow #15 Deep Yellow

- Many recommendations available!

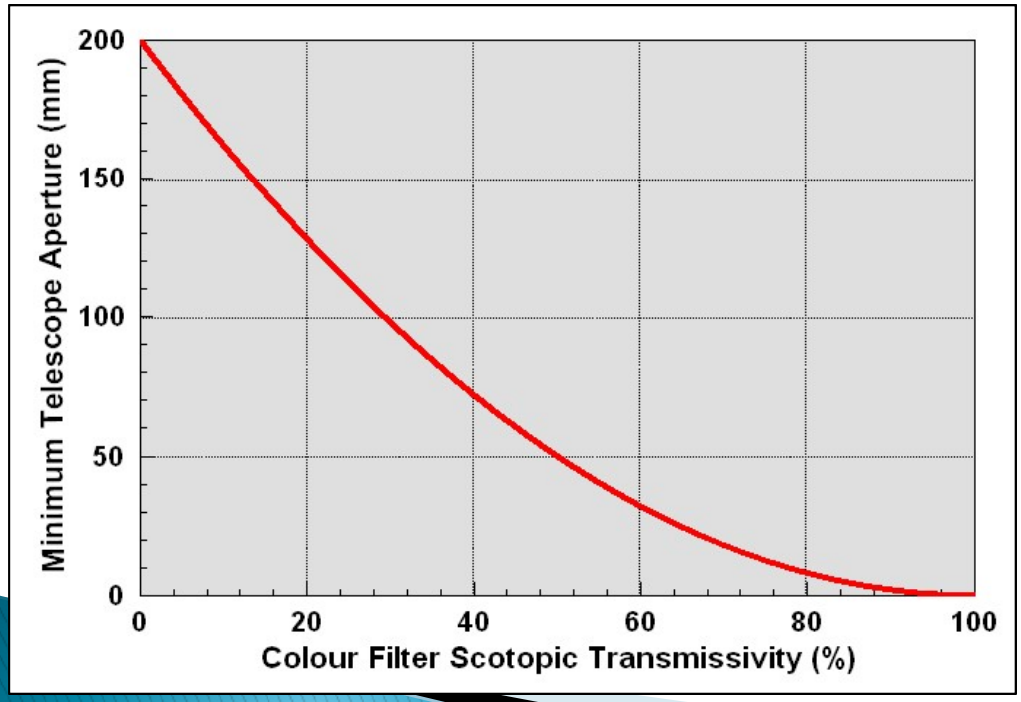
Planetary Filters – The Short…

- Stack of filters + amateur suggestions = science experiment
  - Magenta (CC20M, #47, #30) – Mars, Jupiter
  - Red (#23, #25, #29) – Moon, Mars
  - Light Tan/Orange (#81B, #85) – Jupiter, Saturn
  - Variable Polarizer or ND – Moon, Venus

- Just want single all-purpose filter?
  - Special type – "Moon & Skyglow" (Baader)

Planetary Filters vs. Aperture

- Filters block light…image is darker
  - Limits use of some filters due to scope aperture



filter	colour	%LT photopic eye	%LT scotopic eye
Wratten #1A	lt pink	86.0	85.7
Wratten #30	magenta	29.0	10.3
Wratten CC20M	lt magenta	67.5	70.8
Wratten CC30M	magenta	58.7	62.7
Wratten CC40M	dk magenta	50.7	55.4
Wratten #82A	blue	72.3	76.7
Wratten #82B	blue	64.3	70.6
Wratten #80A	blue	27.8	46.0
Wratten #38A	blue	16.4	37.7
Wratten #47	blue	2.9	17.6
Wratten CC20C	blue	78.5	85.4
Wratten CC40C	blue	69.7	81.7
Wratten CC20B	blue	62.2	70.6
Wratten CC40B	blue	42.5	56.5
Wratten #56	green	52.0	45.3
Wratten #11	green	39.6	38.8
Wratten #58	green	23.3	22.3
Wratten CC20G	green	77.6	75.5
Wratten CC40G	green	67.3	64.0
Wratten #8	yellow	83.6	52.8
Wratten #12A	yellow	75.2	31.1
Wratten #15	yellow	67.6	22.1
Wratten CC20Y	yellow	89.4	79.9
Wratten CC40Y	yellow	87.9	71.4
Wratten #81A	orange	82.2	78.5
Wratten #81B	orange	77.1	72.2
Wratten #85	orange	63.5	47.3
Wratten #21	orange	47.5	7.8
Wratten #23A	red	27.4	1.8
Wratten #25A	red	15.9	0.5
Wratten #29	red	7.2	0.1
Wratten CC20R	red	65.9	61.0
Wratten CC40R	red	48.3	41.2
Wratten #87C	IR	0.0	0.0
Wratten #89B	IR	0.0	0.0
Orion Mars	dk magenta	34.8	69.5
Televue Mars-A	brown	48.6	39.2
Denkmeier Planetary	brown	52.8	54.3
Baader Moon & Skyglow	lt pink	66.4	81.2
Baader Contrast Booster	lt yellow	53.1	48.9

- Most Planets ~ Scotopic
- Moon & Venus ~ Photopic

Solar System Imaging

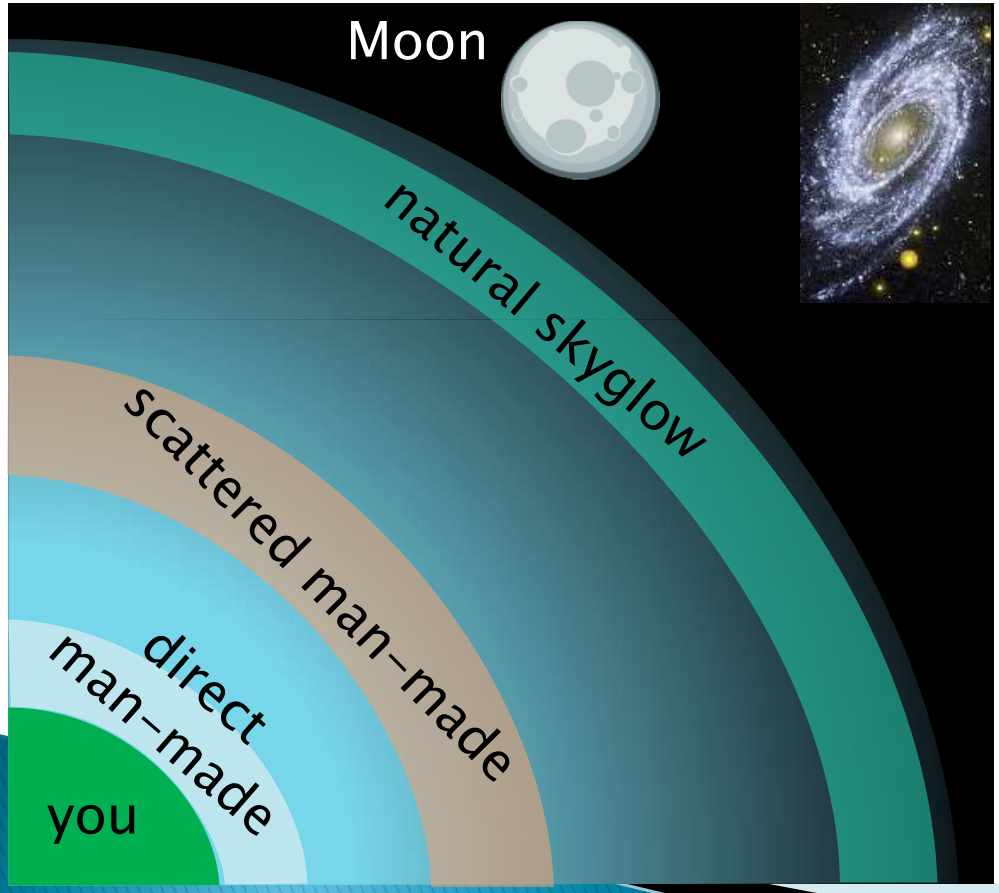
- Contrast, colour, etc. all controlled in post processing

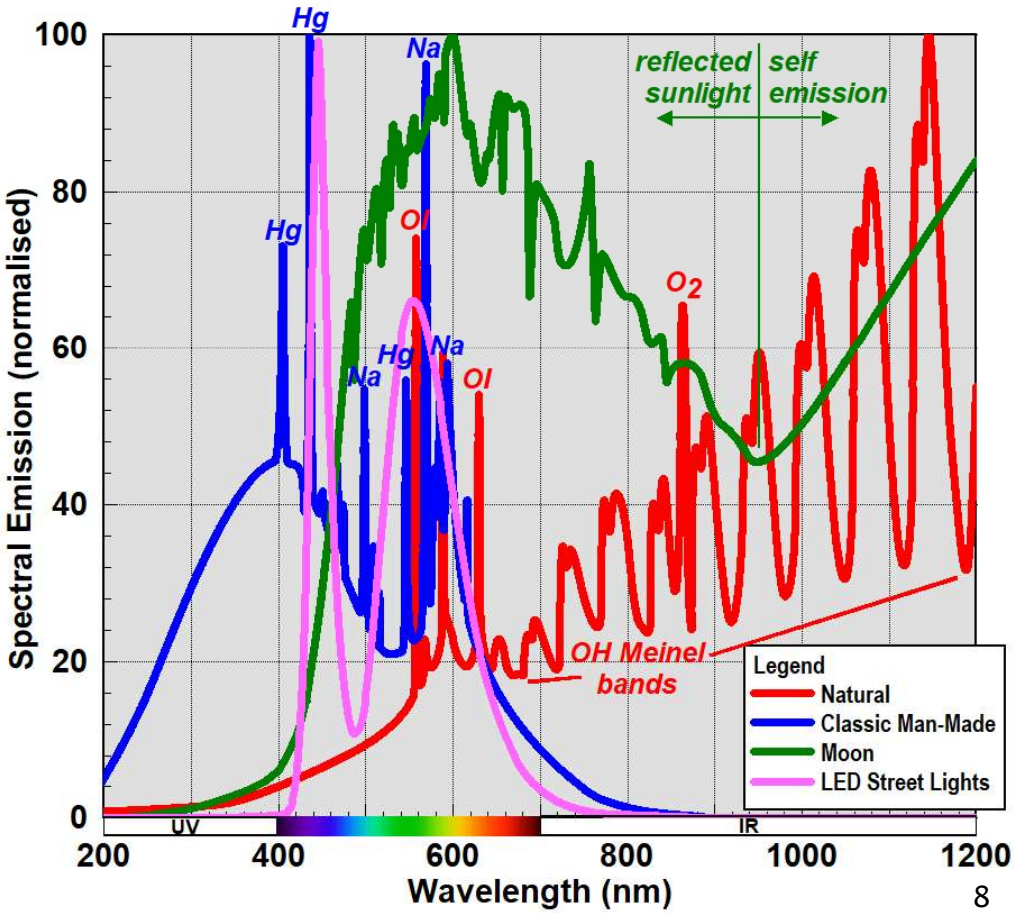
- Main concern is “seeing”
  - At a minimum – UV/IR cut
  - Or try longer wavelengths – red or IR high pass (monochrome)

- Good all-purpose planet/Moon imaging filter
  - “Moon & Skyglow” (Baader, UV/IR cut incl.)

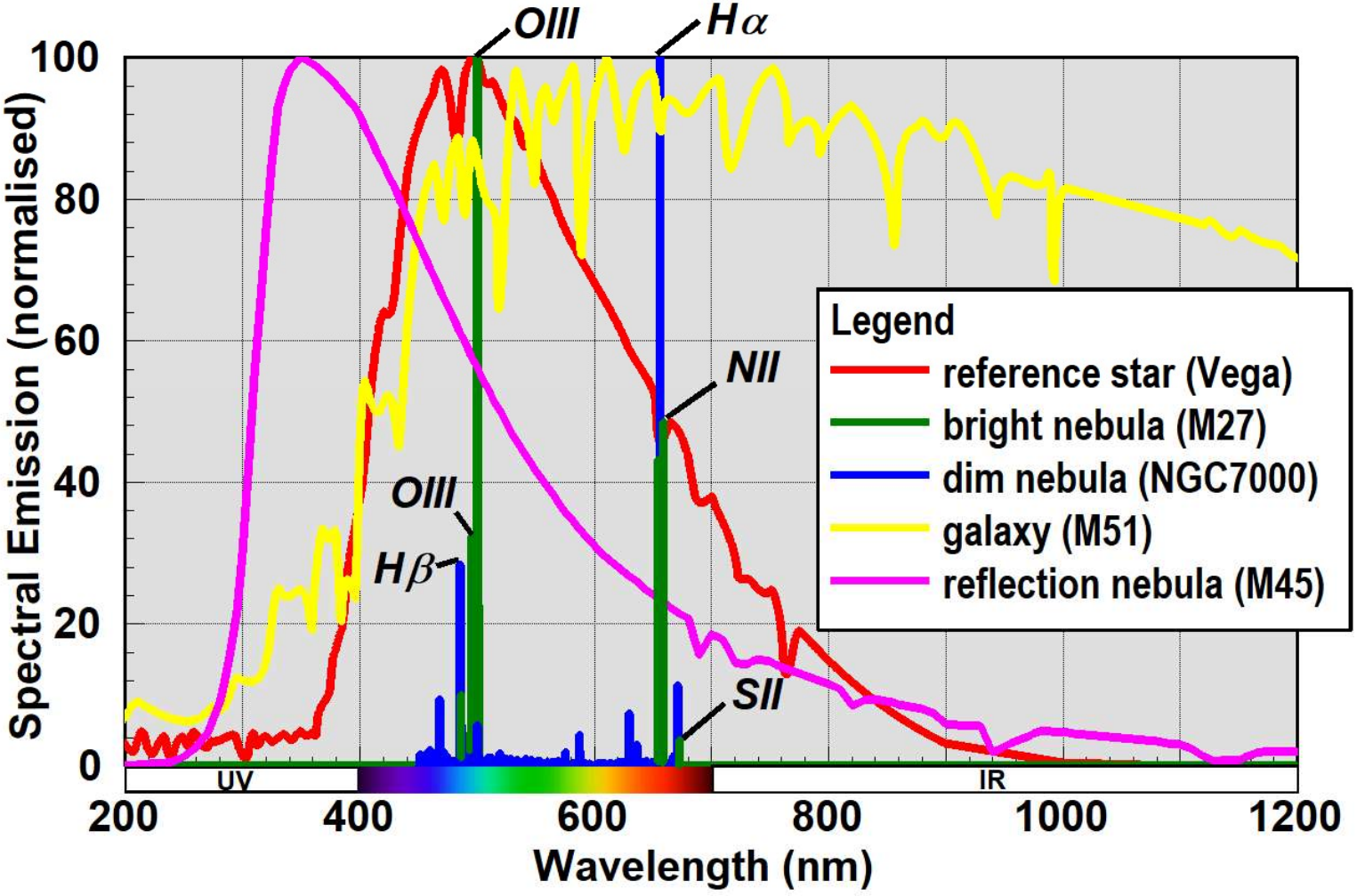
Deepsky Observing Challenges

- Main concern is light pollution



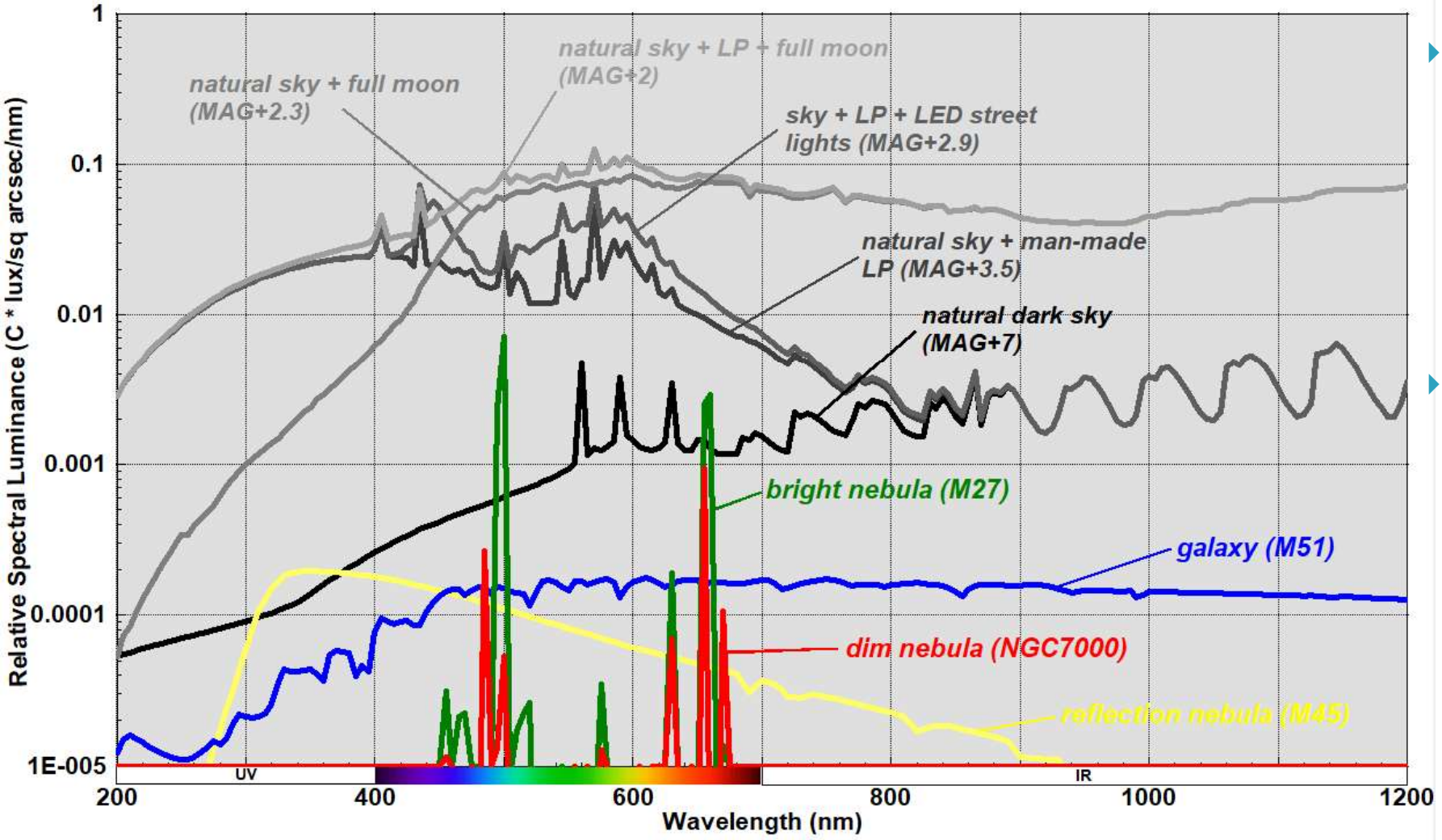


Deepsky Object Spectra



- Stars, galaxies, globular & open clusters, reflection nebulae = broad spectrum
- Emission nebulae (HII, planetary, super nova remnant) = narrow band

LP vs. Deepsky Object

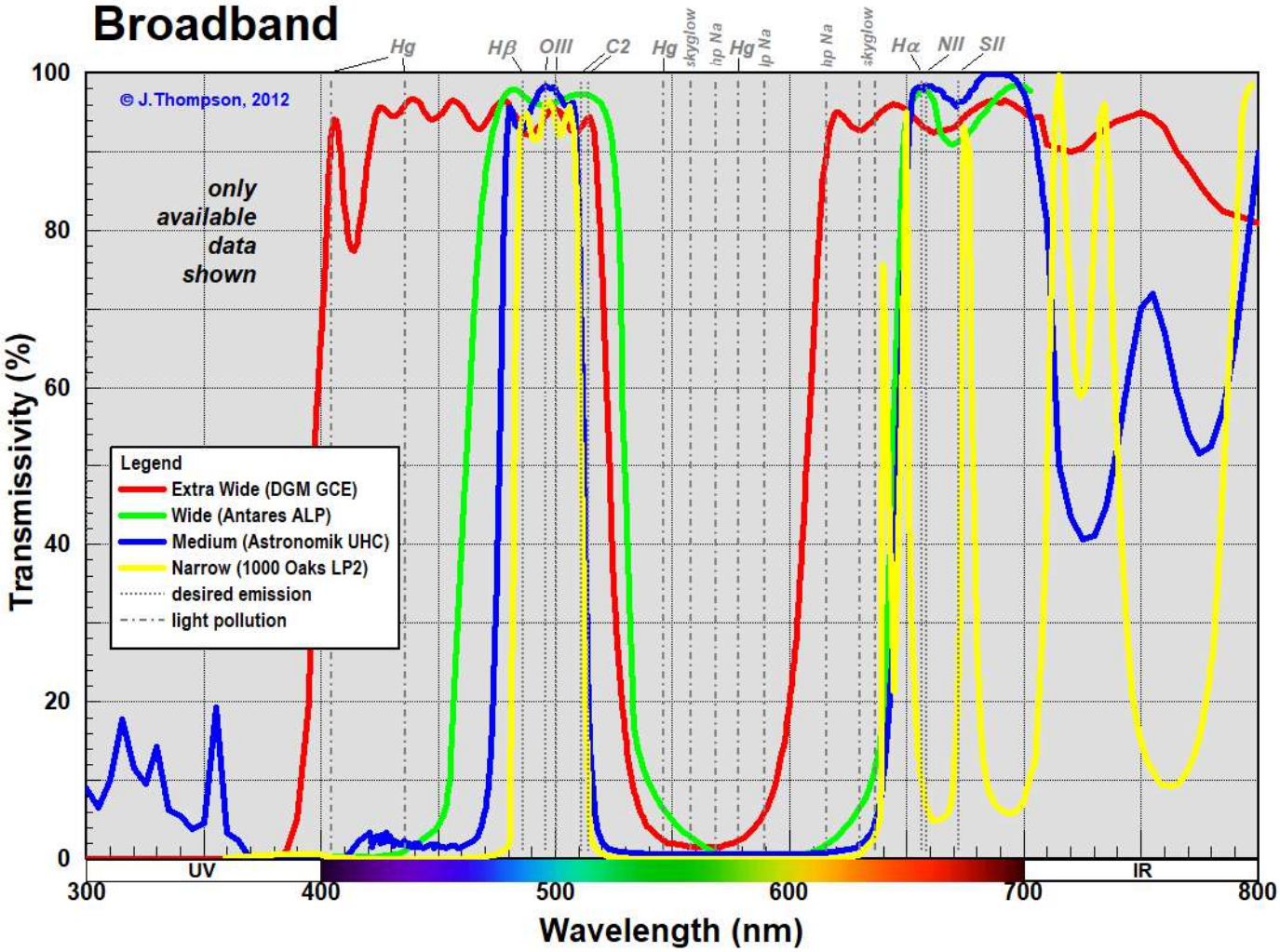


- Min. contrast for human detection ~ 50:1
- Man-made LP makes all but brightest objects NOT VISIBLE

Choosing a Deepsky Filter

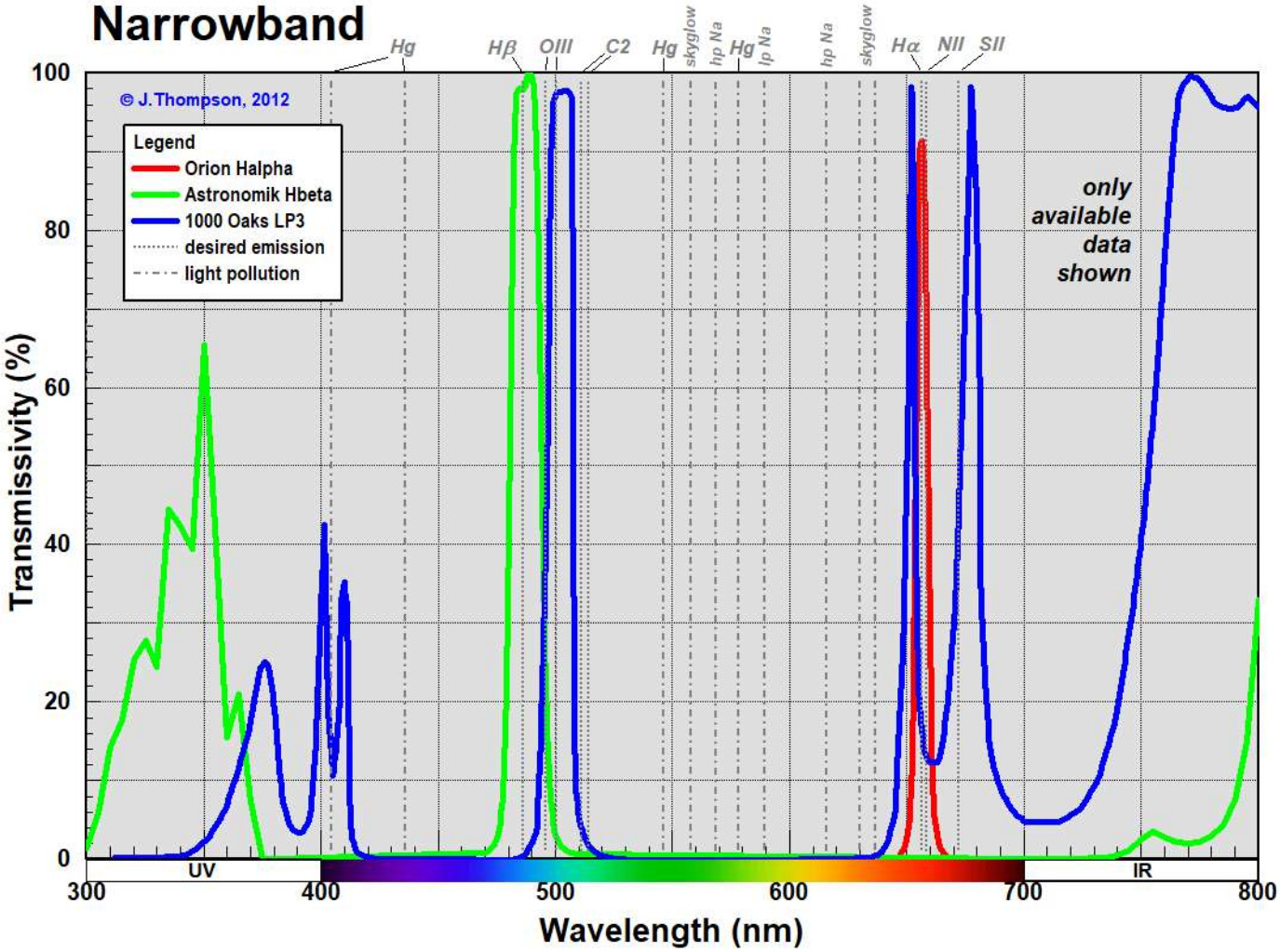
- Like Planetary, want to increase contrast
- Interference type filters more capable
  - precise bandwidths & cut-offs
- Best filter to use depends on:
  - object type (galaxies, clusters, nebulae)
  - amount and type of light pollution
  - size & type of optics
  - tracking capability (video or imaging)

Types of Deepsky Filter – Broadband



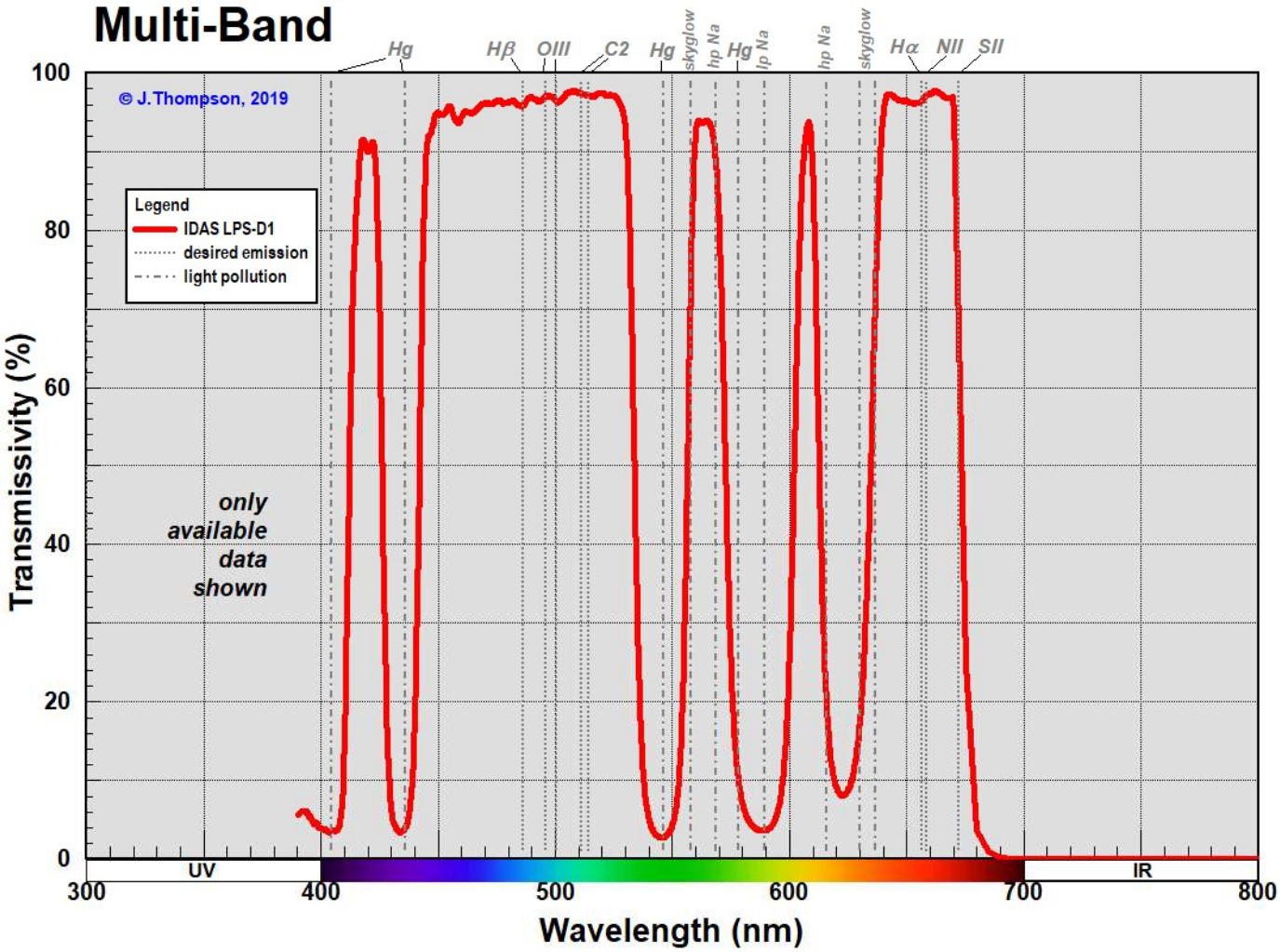
- Large pass band around Hβ & O-III
- Meant for visual so often no Hα
- Can be sub-divided by band width:
  - Extra Wide (>70nm, %LT 62-73%)
  - Wide (50-70nm, %LT 45-62%)
  - Medium (35-50nm, %LT 30-45%)
  - Narrow (20-35nm, %LT 20-30%)
- Band width range supports range of apertures

Types of Deepsky Filter – Narrowband



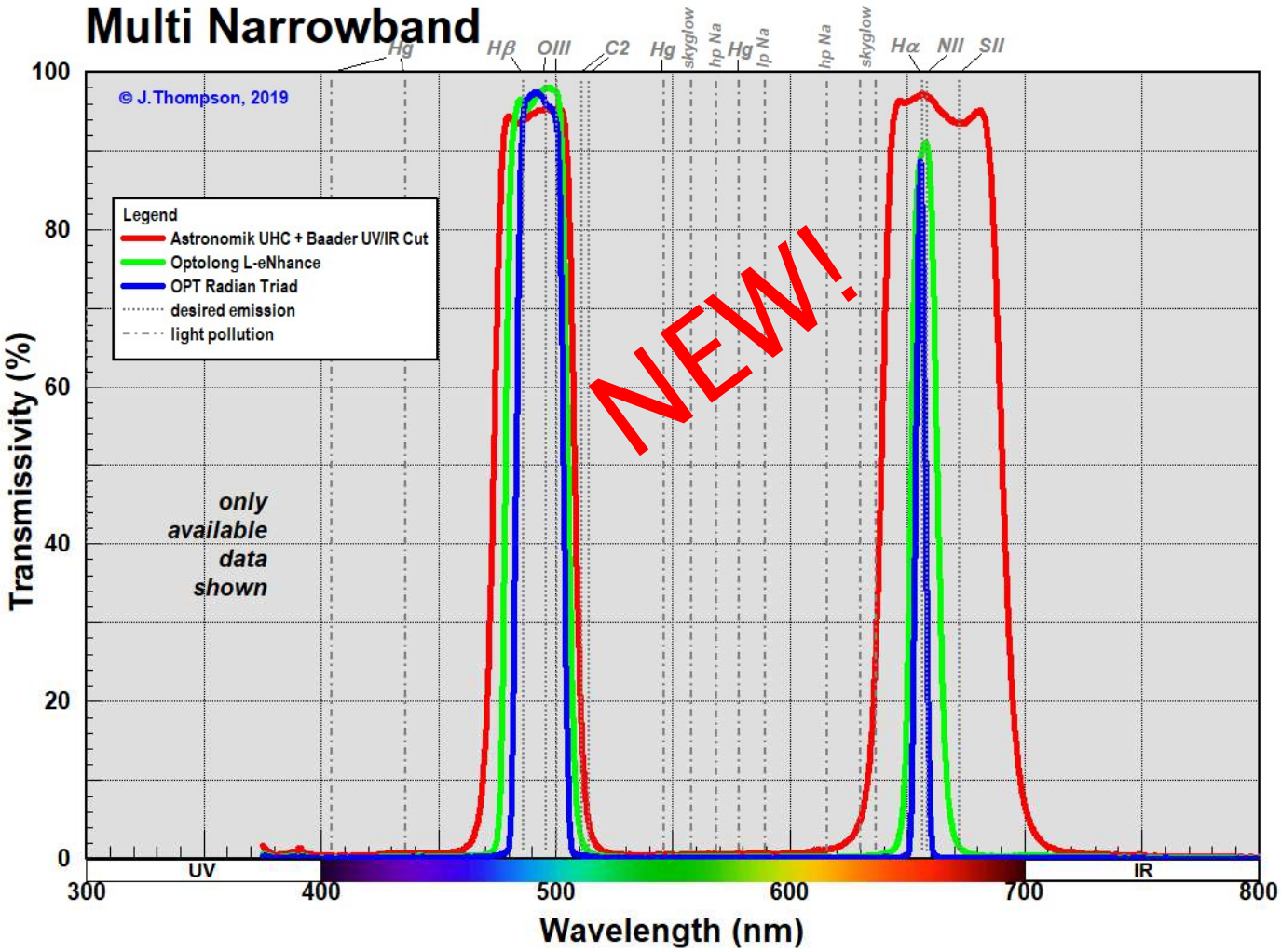
- Narrow pass band around single wave-length:
  - Hβ (486.1), O-III (495.9 & 500.7), Hα (656.5), NII (658.4), or SII (672.4)
- Hα only for video or imaging, NII & SII only for imaging
- Range of band widths available:
  - Visual or Imaging – 10-20nm (%LT 10-20%)
  - Imaging Only – <10nm

Types of Deepsky Filter – Multiband



- Multiple pass bands / blocking bands
- Focus on discrete LP wavelengths
- Provide best white balance – liked by OSC imagers
- Overall LP reduction is moderate-to-poor
- Broadband LP sources greatly reduce effectiveness (eg. LED)
- Visual %LT 50-75%

Types of Deepsky Filter – Multi Narrowband



- Also called: duo-band, tri-band, or quad-band
- Pass bands around more than one emission wavelength
- Maximize LP blocking when observing or imaging emission nebulae
- Recently become popular w/ OSC imagers
- Visual %LT 8-34%

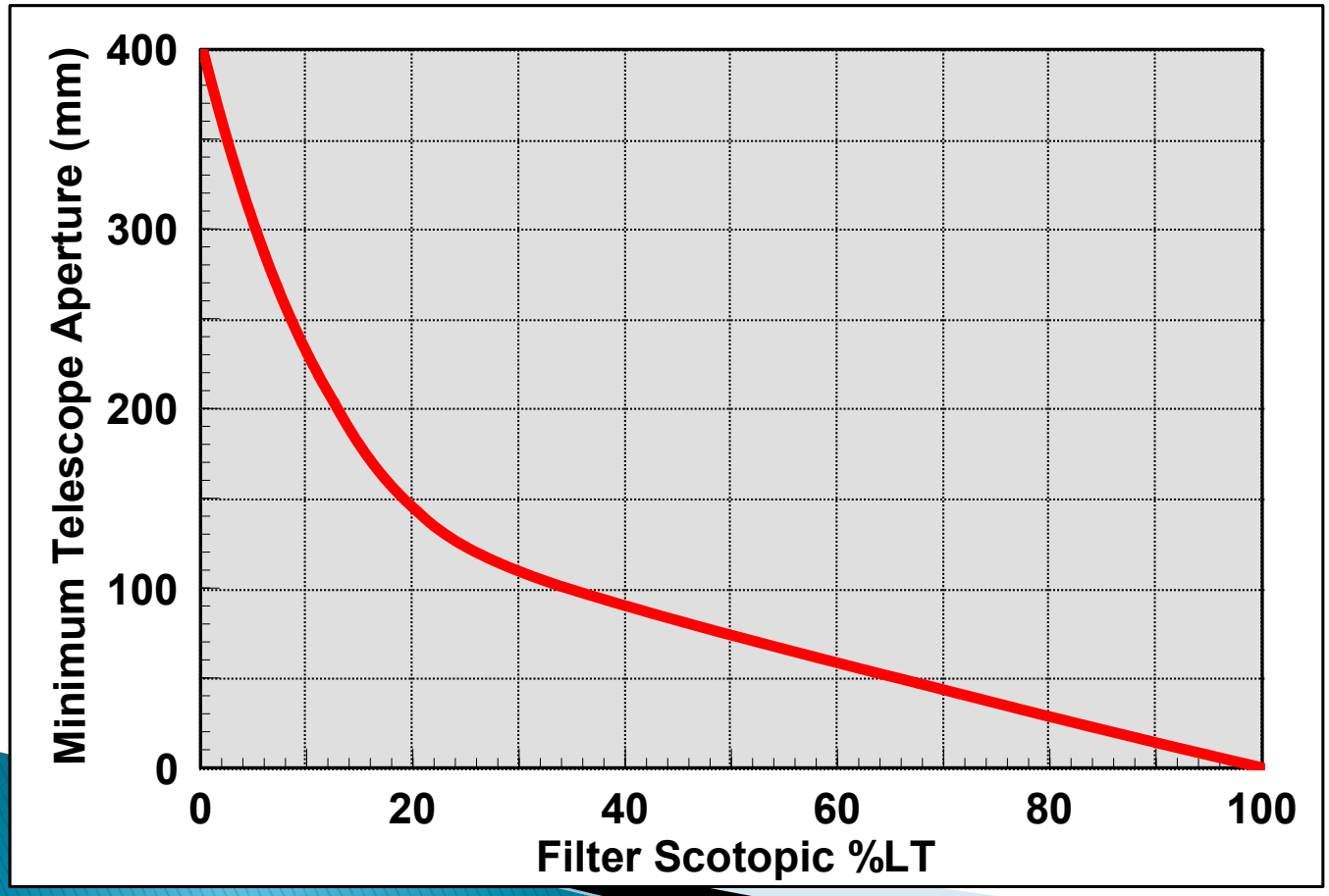
Choosing a Deepsky Filter, cont'd

Object Type	Dark Sky	Light Polluted Sky
Emission Nebulae (incl. planetary neb. & supernova remnants)	- Narrowest deepsky filter your aperture (visual) or mount tracking (video/imaging) will support. Adding IR cut can also help improve contrast with camera.	
Galaxies, globular clusters, open clusters, reflection nebulae	- Don't use filters visually. - Adding IR cut can help contrast with camera.	- No significant benefit visually. - Video/imaging filters that pass IR are req'd, w/ wide to medium band pass filters working best. Even more contrast on galaxies w/IR high pass filters, but long exposure time req'd.

- Unfocused IR in refractors (video/imaging):
  - Most ED doublets and APO triplets not a problem
  - Commercial camera lenses (esp. security) usually need IR cut

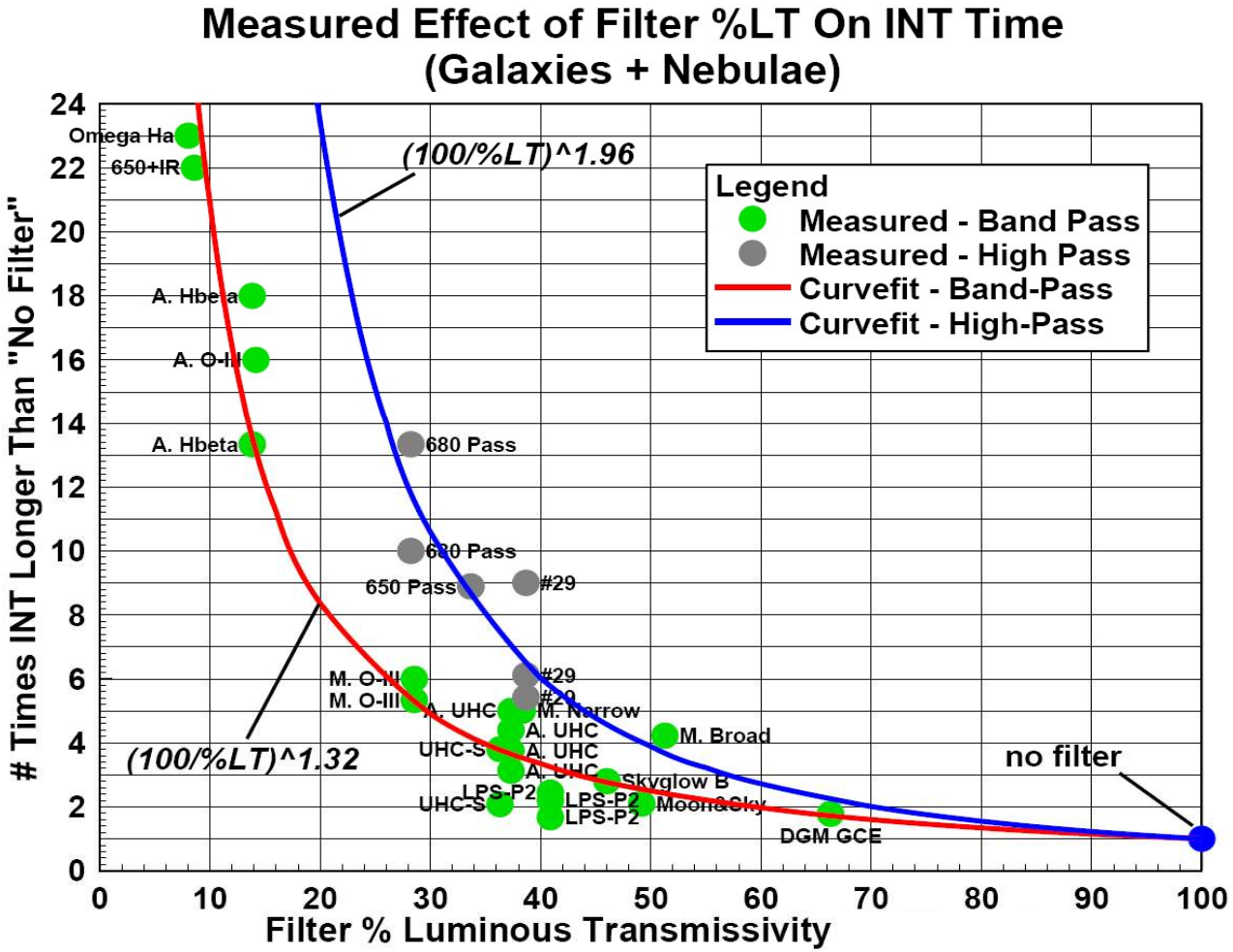
Deepsky Filters vs. Aperture

- Recall that filters make scene darker



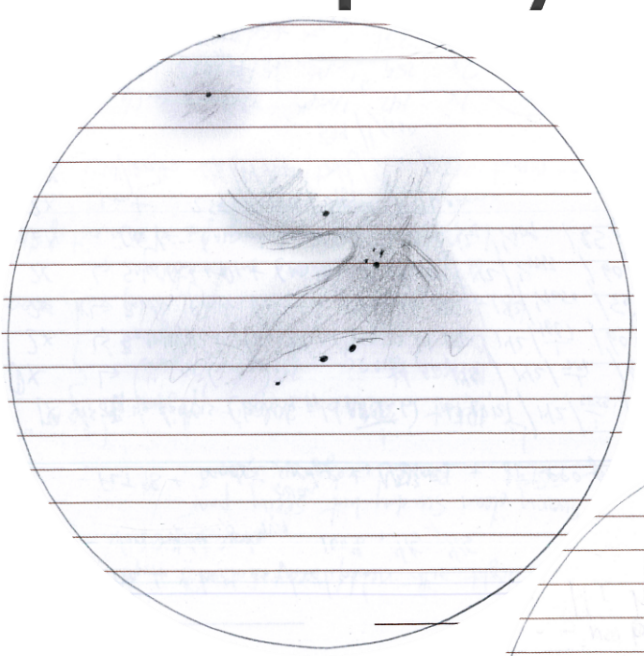
- %LT of filter limits practical scope aperture for visual use
- no limit on aperture for video/ imaging – compensate w/exposure time

Deepsky Filters & Exposure Time



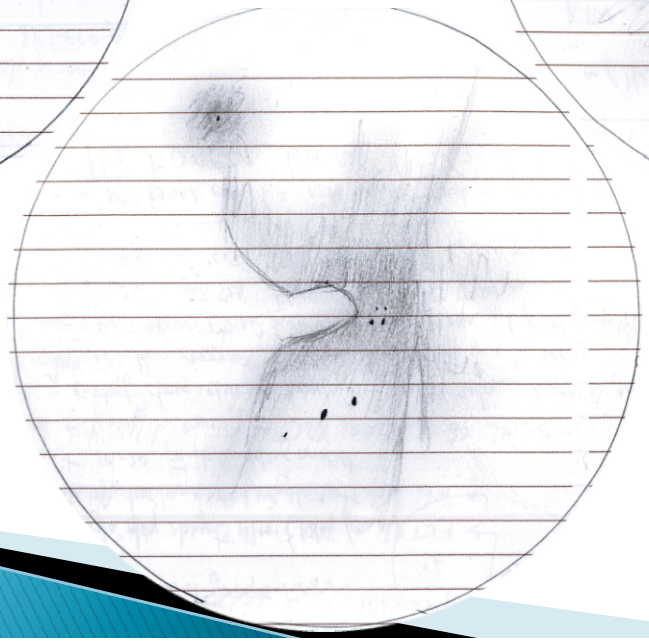
- Darker background allows longer exposures to further increase image contrast
- Impact on exposure time is much greater for galaxies & reflection nebulae

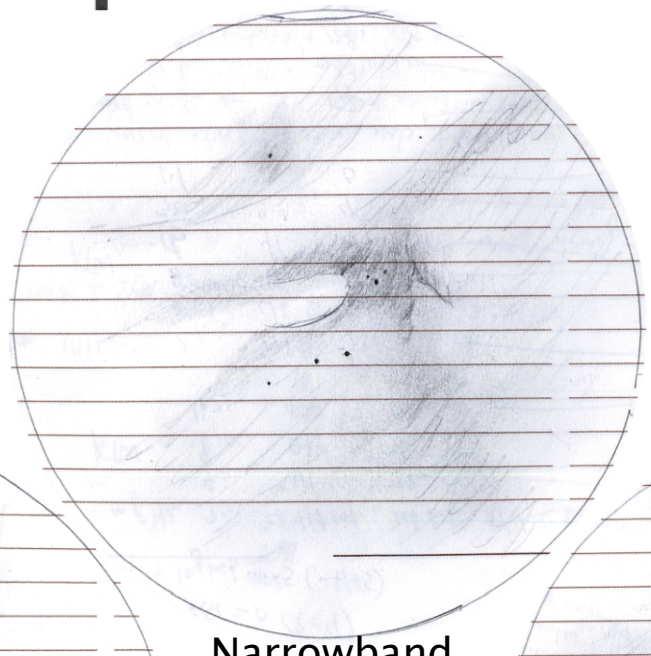
Deepsky Filter Impact – Visual



No Filters

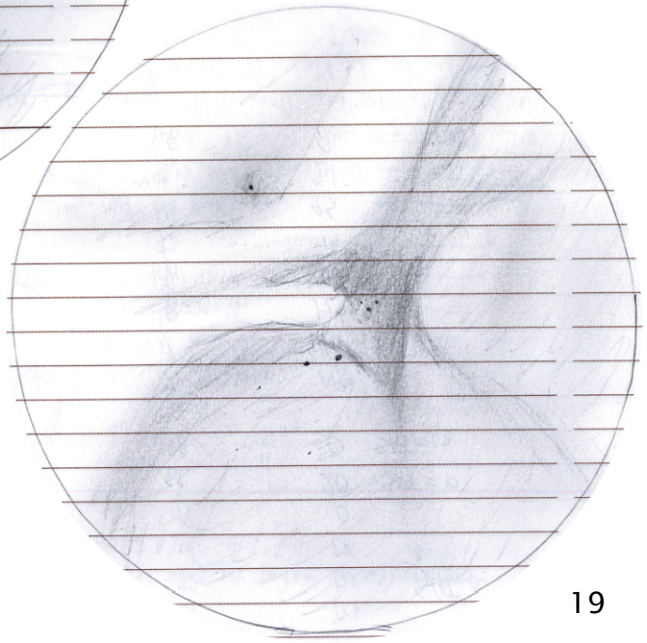
Medium Band





Narrowband O-III

Narrow Tri-band



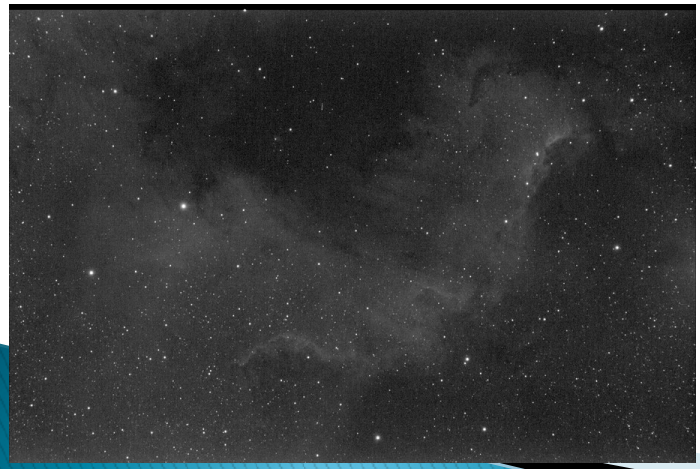
- Downtown Ottawa (Mv ~ +3.5)
- 4” APO refractor
- 6.7mm UWA eyepiece

Deepsky Filter Impact – Imaging

No Filters

Wide Band

Medium Band



Medium Band + IR Cut

Narrow Tri-Band

Narrow Band Halpha

Deepsky Filter Impact – Video

Semi-dark sky
(Petawawa)
3” refractor

IDAS LPS-P2 (60sec INT, 0 BRT)

Meade O-III + BDRB (60sec INT, ~40 BRT)

IDAS LPS-P2 (60sec INT, 0 BRT)

Meade O-III + BDRB (60sec INT, ~70 BRT)

Deepsky Filter Impact – Video

Dark sky (Foymount) 8" SCT

No Filters (60sec INT, 54 BRT)

Astronomik UHC + IR cut (60sec INT, 82 BRT)

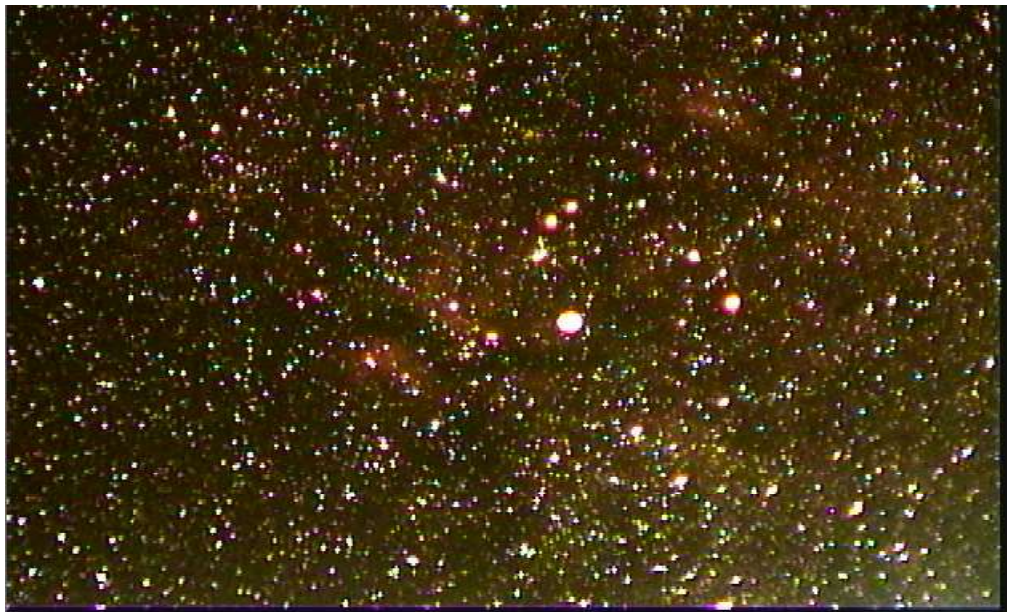
Meade O-III + BDRB (60sec INT, 93 BRT)

Meade O-III + BDRB (120sec INT, 82 BRT)

UV/IR Cut & Achromats

Dark sky (Foymount)

No Filters (20sec INT, 0 BRT)



Baader UV/IR Cut (45sec INT, 0 BRT)

- Captured w/achromatic Canon TV camera lens (17-102mm zoom)
- Unfocused IR very evident – not simply bloated stars, fuzzy stars

Some Other Effects of Filters

- Adding filter will change white balance (WB)
  - Broadband = magenta, O-III = green, Hbeta = cyan, Halpha = red, IR pass = orangish-brown
  - Some filters provide better WB than others (eg. IDAS LPS-P2)
  - May not be able to completely correct for the filter (video/imaging)

- Filter glass another surface in optical train
  - can cause reflections, better quality filters have anti-reflective coatings
  - another surface upon which dirt, dust, or dew can settle – most evident with bright objects

You Get What You Pay For

- Tempting to buy cheapest, but quality suffers
  - reflections, de-lamination, poor machining, optical distortion, poor transmission

- (Too) Many filter manufacturers available
  - Premium ($$$$): Andover, Astrodon, Chroma, Custom Scientific, FLI, OPT Radian
  - High Quality ($$$): Astro Hutech, Astronomik, Baader, Lumicon, Televue
  - Good Value ($$): 1000 Oaks, Meade, Optolong, Orion
  - Discount ($): Antares, Arcturus, DGM, Omega (on Ebay)
  - Avoid: Canadian Telescope, Celestron, Kson, Olivon, Omegon, Optical Vision, Sirius, Svbony, Zhumell

Last words

- Feel free to experiment. Recommendations here are based on MY experience; yours may be different.
- Do not feel obligated to buy one of everything. Start with a good quality general purpose filter you can afford & build from there.
- For goodness sake HAVE FUN!
- Next time:
  - “Special” filters