Understanding Astronomical Filters

Part I: What Are They?

By: Jim Thompson
Presented: RASC Ottawa, Jan.2020

Overview

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

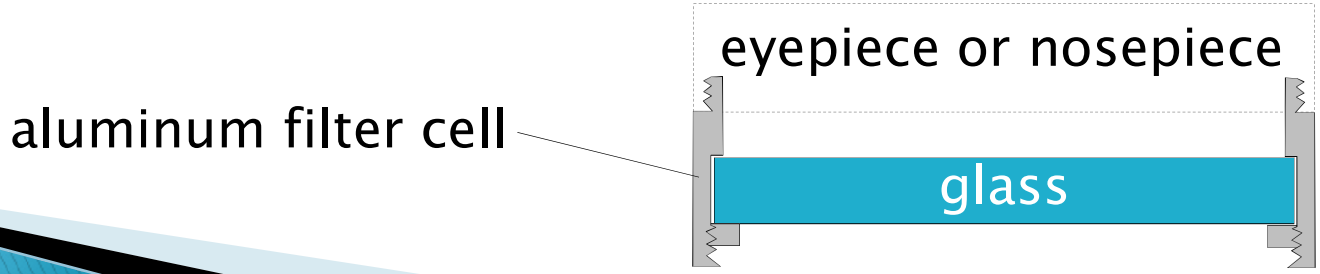
What Do Filters Do?

Block Light You Don't Want To See

- Improve contrast & sharpness
- Emphasize features
- See faint details

Filter Function

- Piece of glass designed to make what we don't want to see darker
- Makes what we want to see easier to see (<u>but not brighter</u>)
- Block light by: absorption or reflection



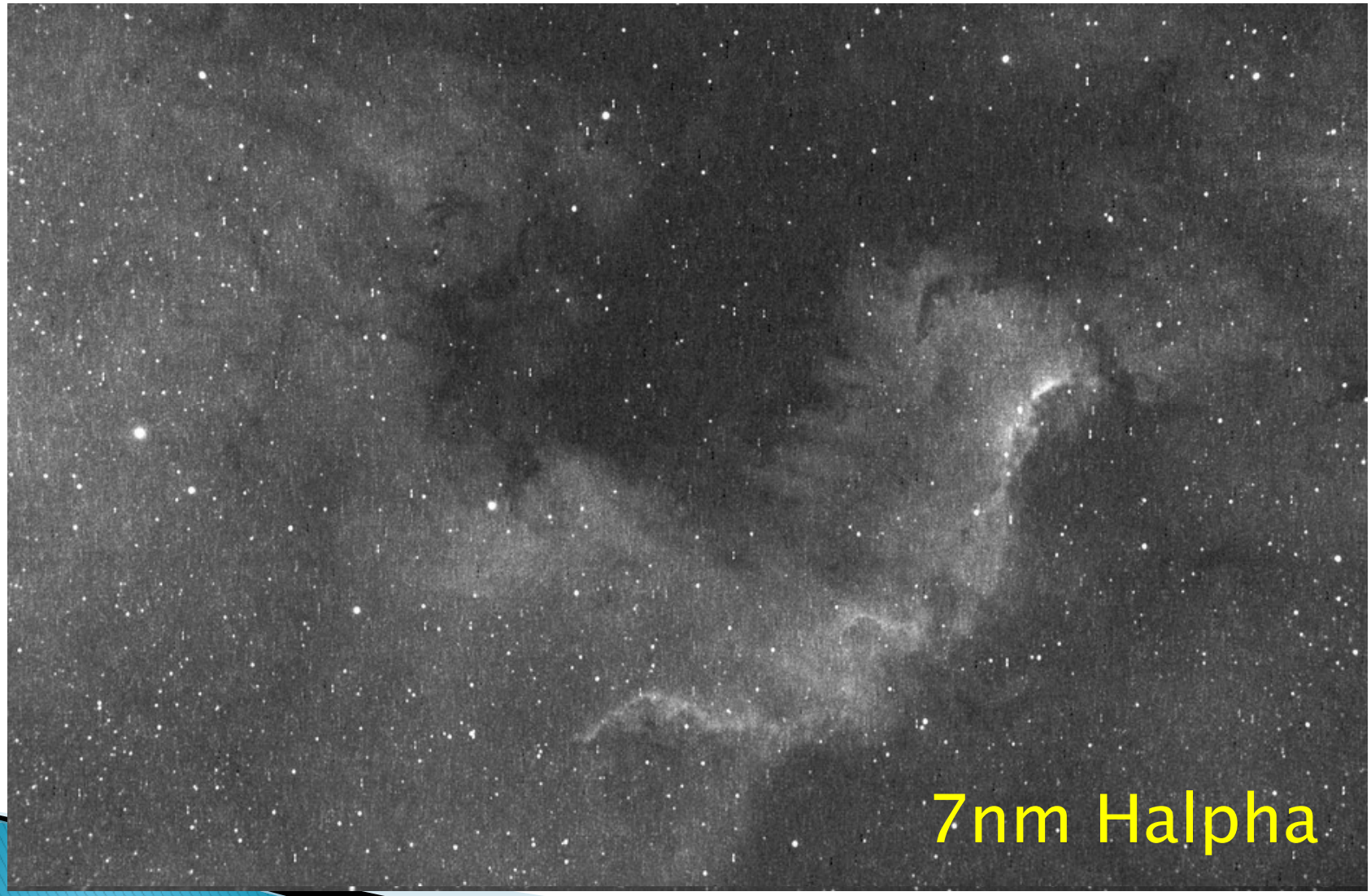
Example Application – Planets

From Earth

Green Filter

simulated images

Example Application – Deepsky



Types of Filters

- Planetary
- Colour (Wratten)
- Absorption

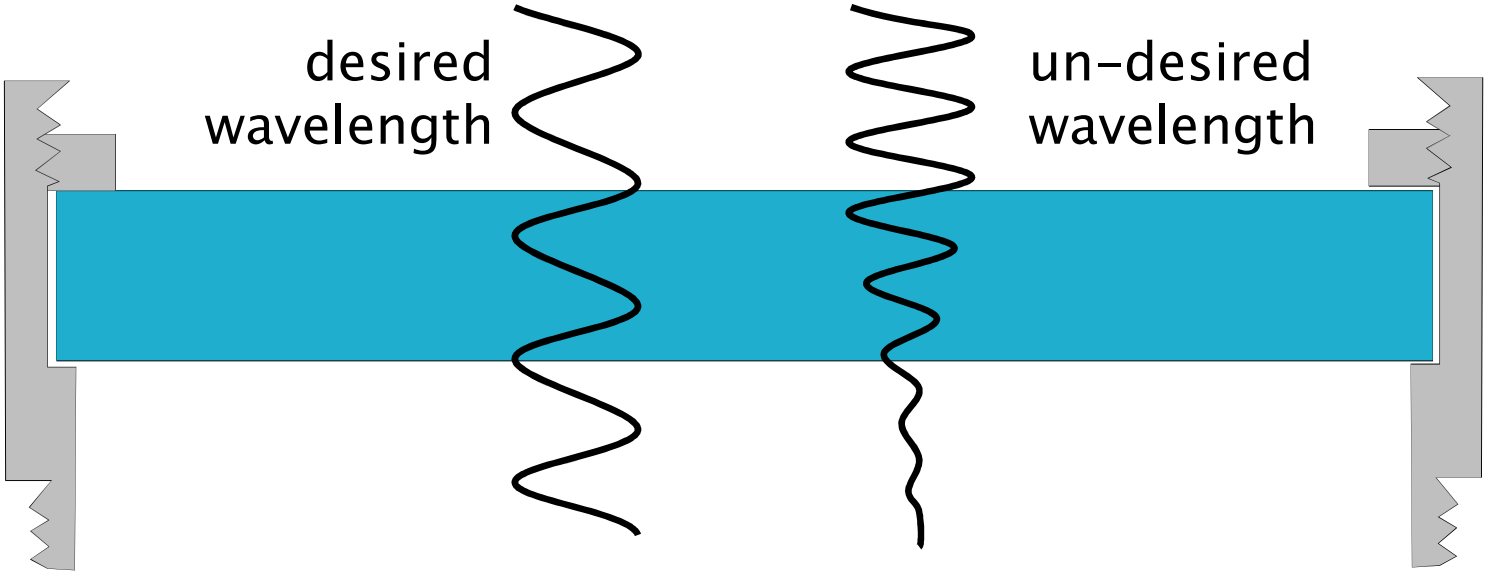
- Deepsky
- Nebula
- Light Pollution
- Interference (reflection)

Special Filters

- Some special interference type filters also exist for:
  - Planetary observing
  - Chromatic aberration correction
  - Solar observing
  - UV/IR blocking

- Let's ignore for now

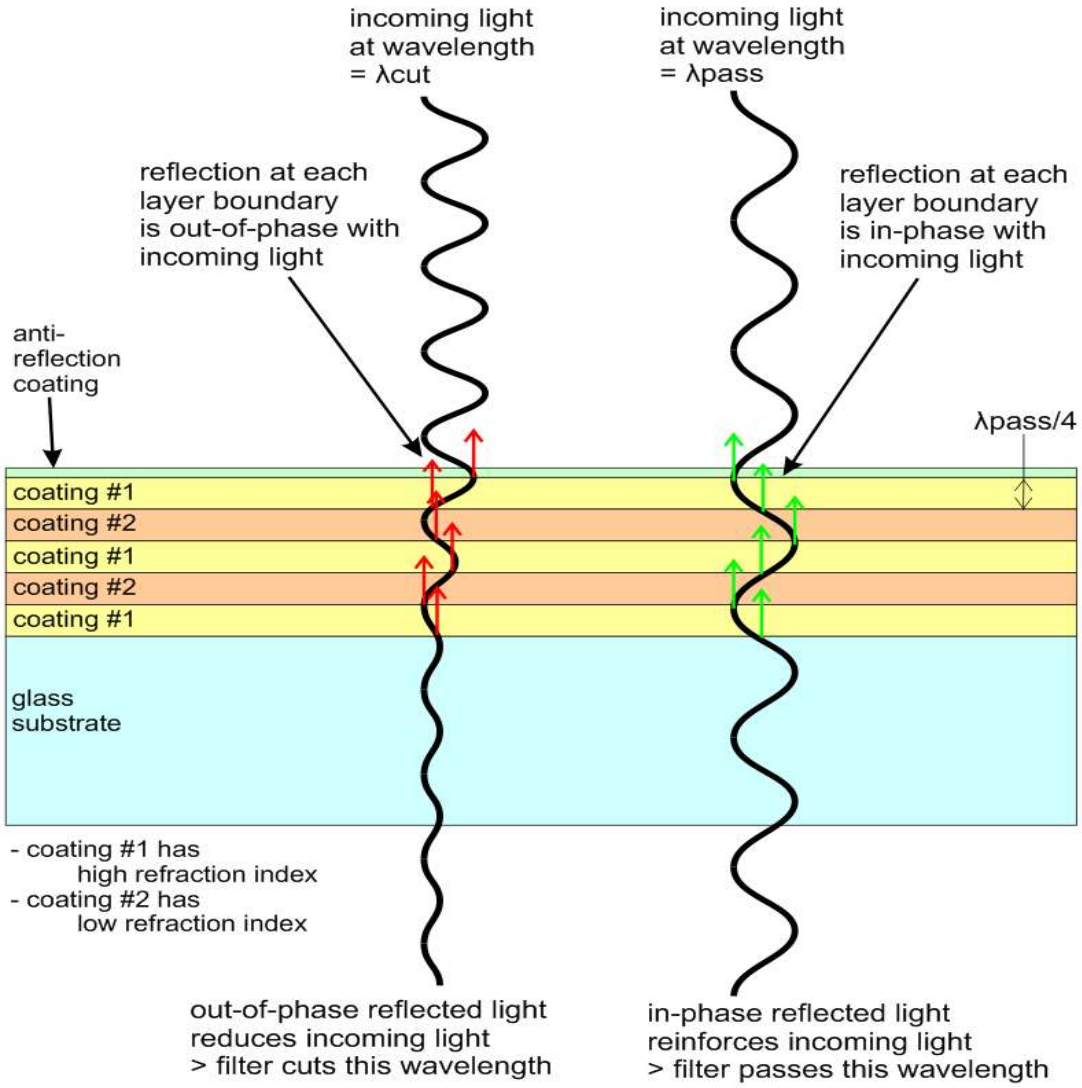
Absorption filters



- Dye infused glass, or gel sandwiched between glass
- Molecules in dye absorb some wavelengths but not others
- Broad pass bands, very gradual cut-offs

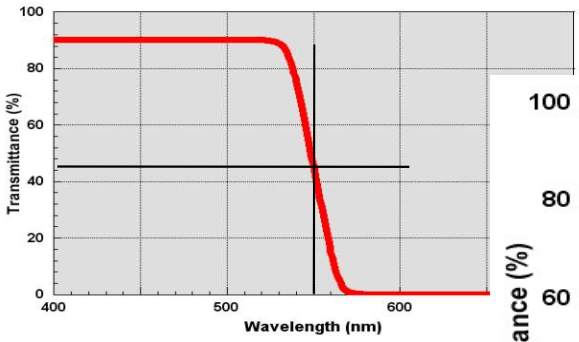
* Wratten (bought by Eastman Kodak in 1912)

Interference filters



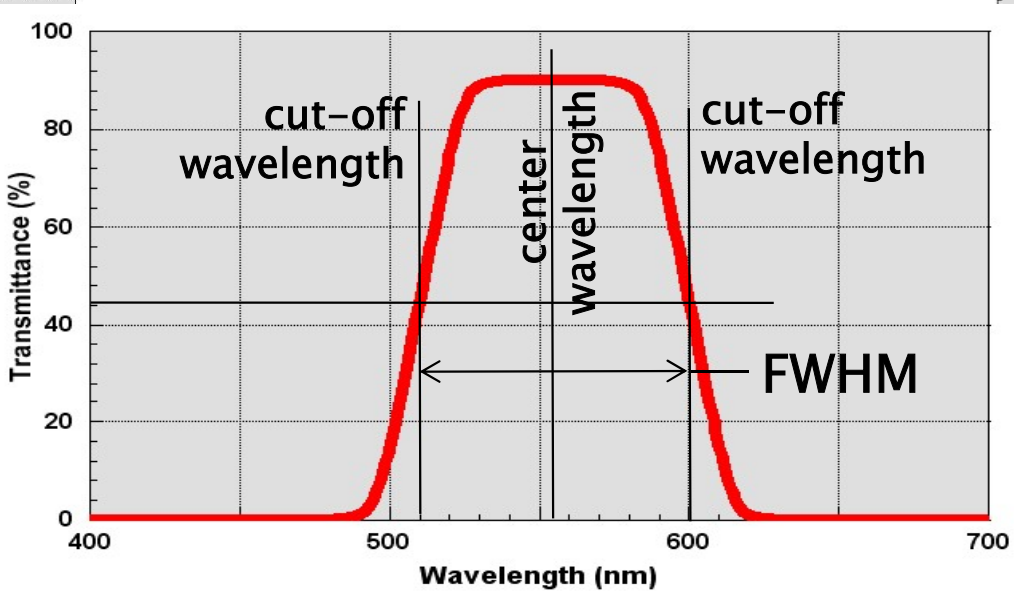
- 10's to 100's of alternating coatings on a glass substrate
- each coating has different refractive index
- light partly reflects at each boundary
- by design all undesired wavelength reflections are out-of-phase – null each other out

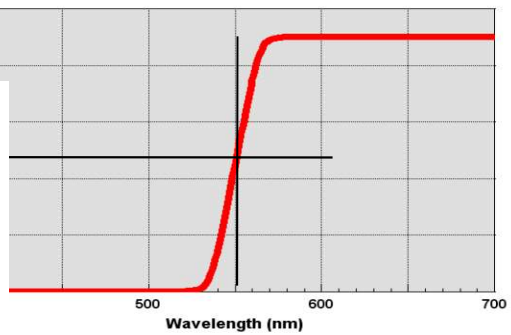
Filter response nomenclature



low pass

wide band pass

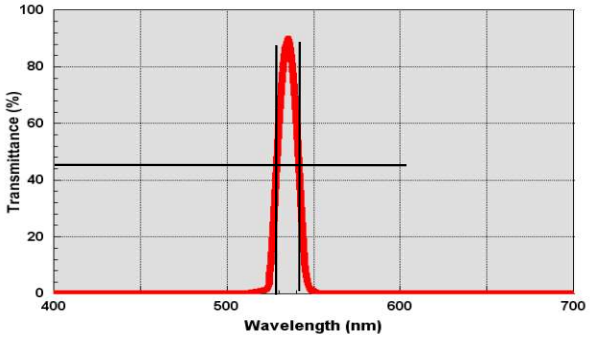




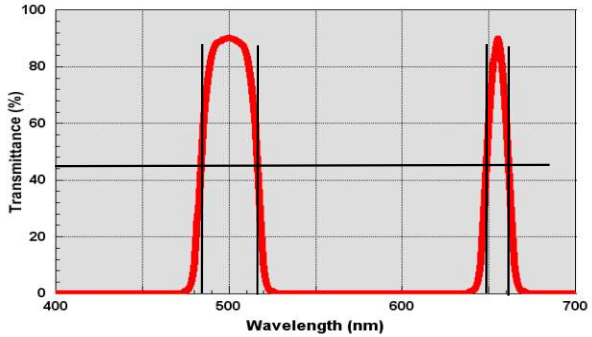
high pass

(block)

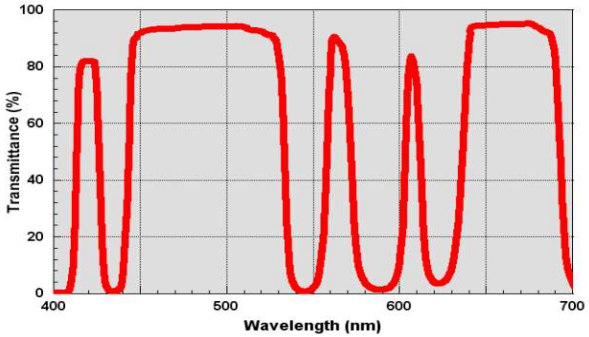
narrow band pass



dual band pass

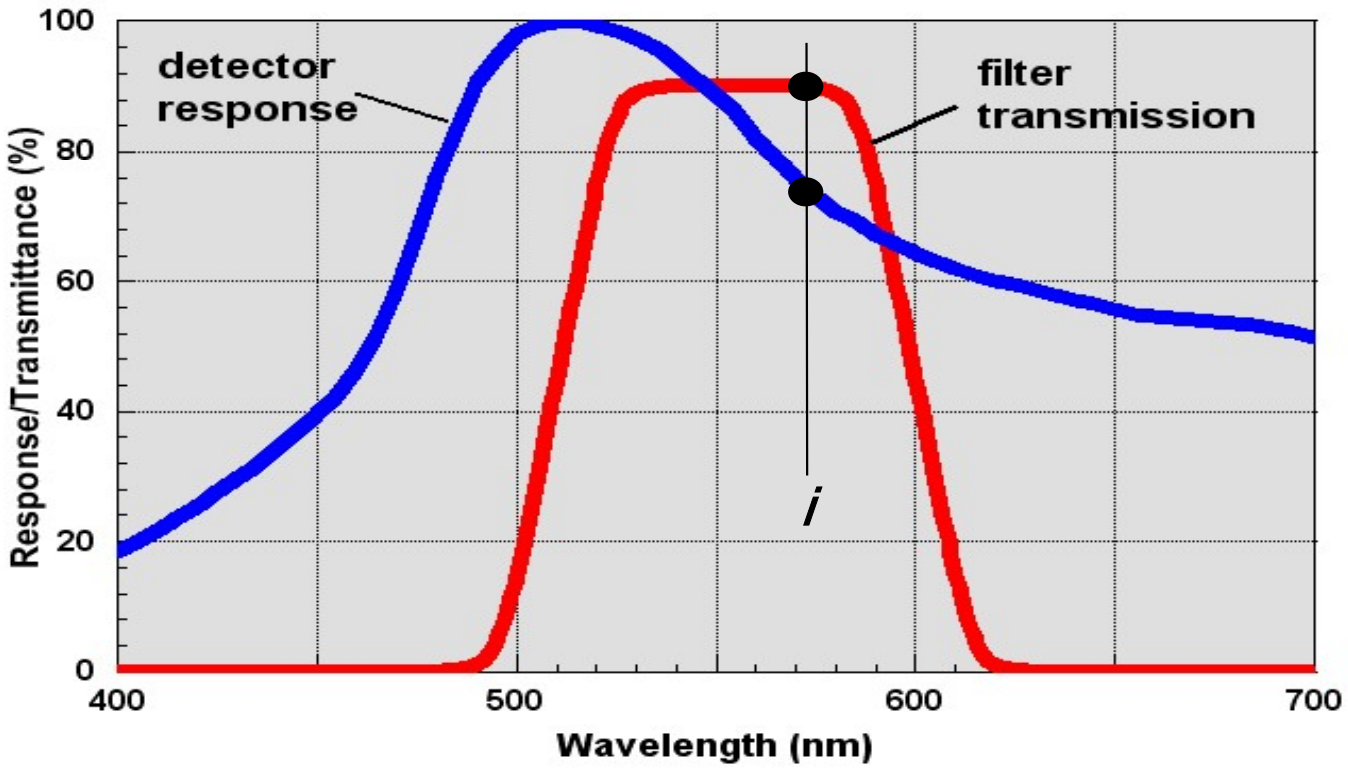


multi-band pass



Luminous Transmissivity (%LT)

- Measure how "dark" filter is (how much light it blocks), w/ 100% = clear
- Calculated based on response of detector (eye, CCD, …)
- Most often quoted assuming daytime visual use!



- Average brightness weighted by detector sensitivity

$$\%LT = \frac{avg(\%DR_i * \%FT_i)}{avg(\%DR_i)}$$

, where $i = \lambda 1$ to $\lambda 2$

Last words

- Brief introduction to astronomical filters
- Useful addition to your gear – visual or imaging
- Next time:
  - using filters
  - filters worth having