OPTICAL COATINGS FOR AMATEUR ASTRONOMERS

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Eridanus Optics CC

Coatings are everywhere!

- Telescopes
  - Meade: UHTC
  - Celestron: XLT
- Binoculars: Multi coated
- Eyepieces
  - (Fully) Coated
  - (Fully) multi coated
  - Phantom coated (Baader Planetarium)
- Filters
  - Phantom coated

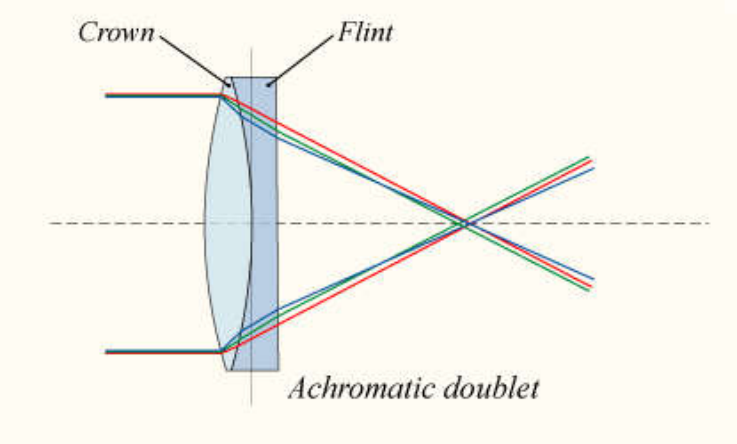
Why apply coatings to optics?

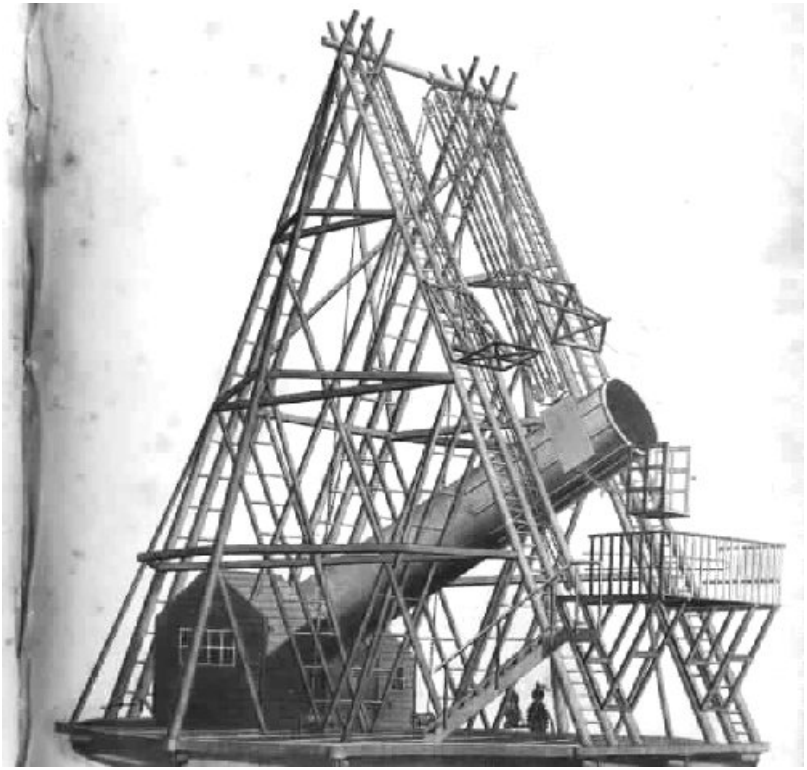
We want to see the more!

- Large aperture
  - More light
  - Smaller diffraction limit
  - Higher magnification
  - More detail!
- Drawbacks (Technical)
  - Chromatic aberration
  - Spherical aberration
  - Coma
  - Astigmatism
- Drawbacks (Practical)
  - Handling
  - **Cost**

What is the solution?

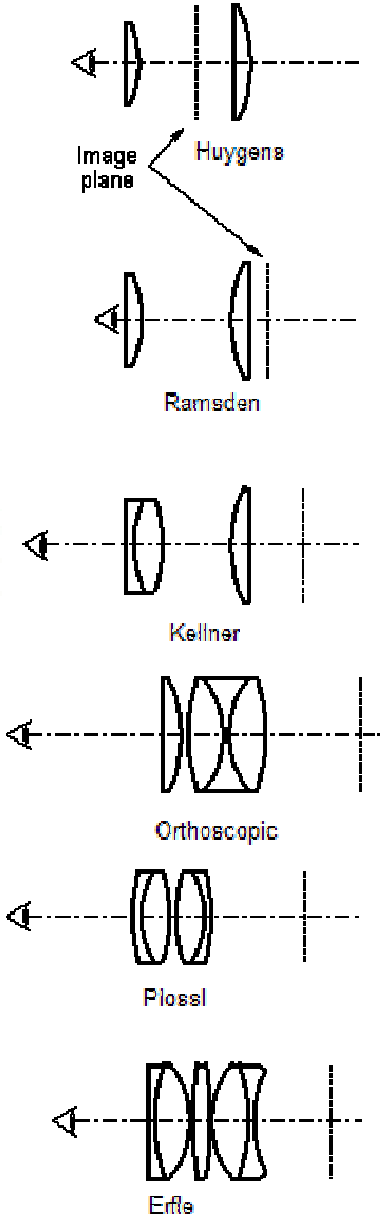
- Achromatic lens
- Apochromatic lens
- High F/#
  - Long focal length
- Reflector/Catadioptric
- Eyepiece design





An eyepiece is an eyepiece?

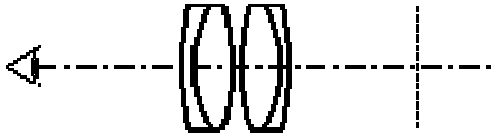
- Different designs/ implementations
  - Focal length
  - Field of view
  - Field flatness/distortion
  - Eye relief
  - Coma correction
  - Color correction
- Eyepiece complexity
  - Number of lenses used
    - Light loss due to reflections



How much light is lost?

- Uncoated:
  - Air/Crown: 4.3%
  - Air/Flint: 5.5%
  - Crown/Flint: 0.08%
  - Air/Glass (typ): 5%
- Coated:
  - Single layer: 2%
  - Multi-coated: 1%
  - Super-coated: <0.5%

Light lost:



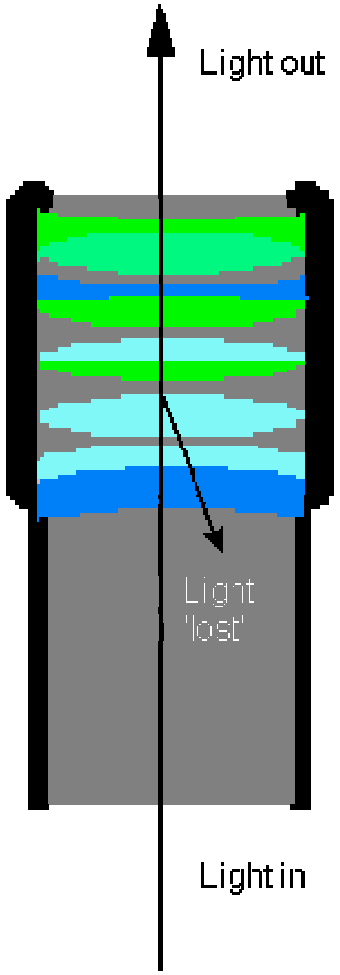
- Plossl
  - Multi-Coated: 11.6%
  - Fully MC: 4%
- Hyperion (5 lensgroups)
  - Uncoated: 40%
  - Phantom coated: 4.9%

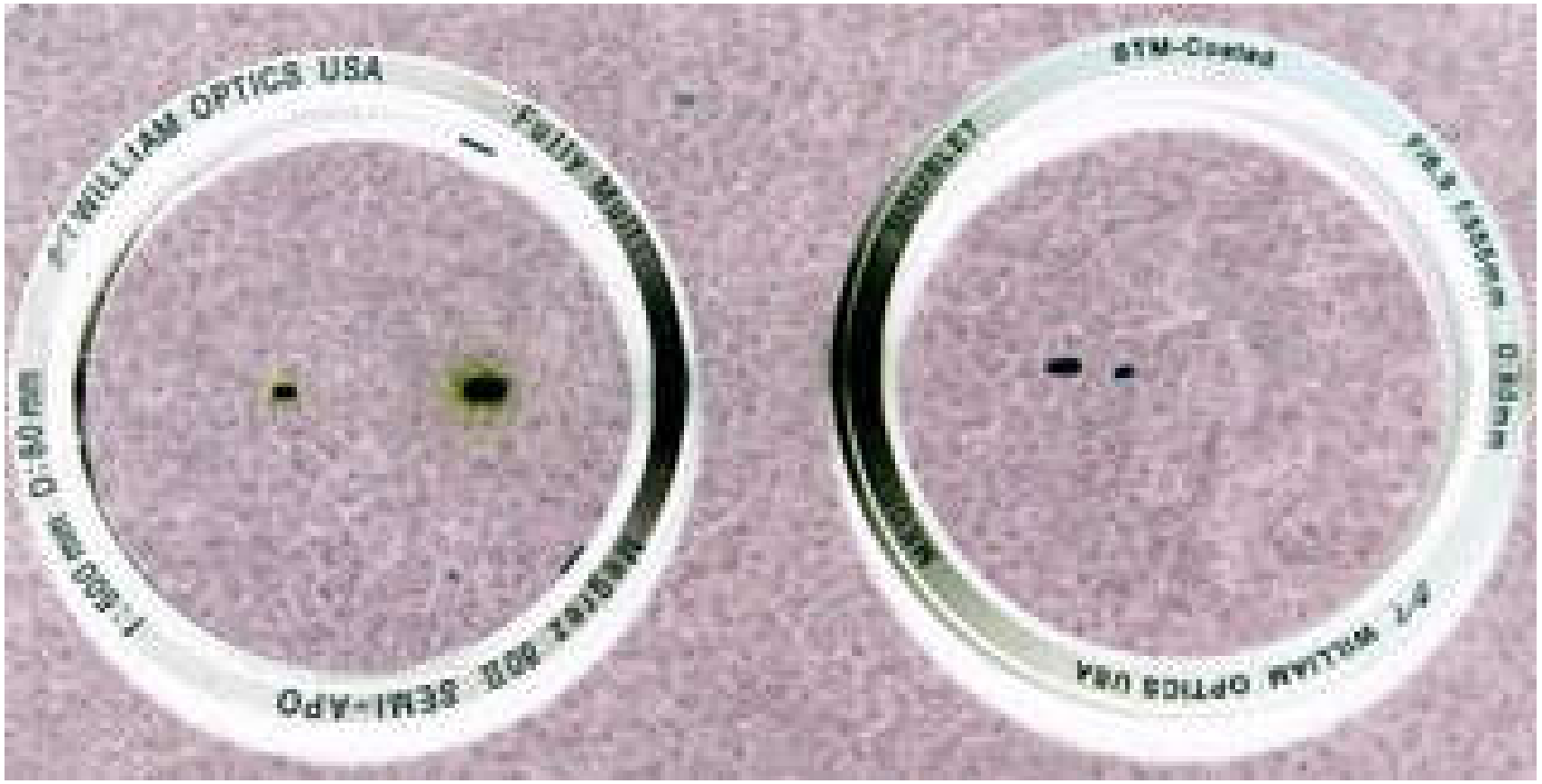
Phantom Group Coatings

- 0.2% maximum from 490 to 540 nm
- 0.5% maximum from 400 to 470 and from 560 to 700 nm
- Highest efficiency around 520 nm

That is not the only bad news!

- 11.6% loss of light (Multi-coated Plossl)
  - 6% loss in light gathering ‘aperture’
- 11.6% of received light ‘trapped’ inside eyepiece (13% of light out)
  - Self generated ‘light pollution’
  - Reduced contrast!
  - Ghost images
- Modern high performance eyepiece
  - Uncoated: 40% loss
  - Supercoated: 5% loss
- In partially coated optics, the wrong surface is typically coated!

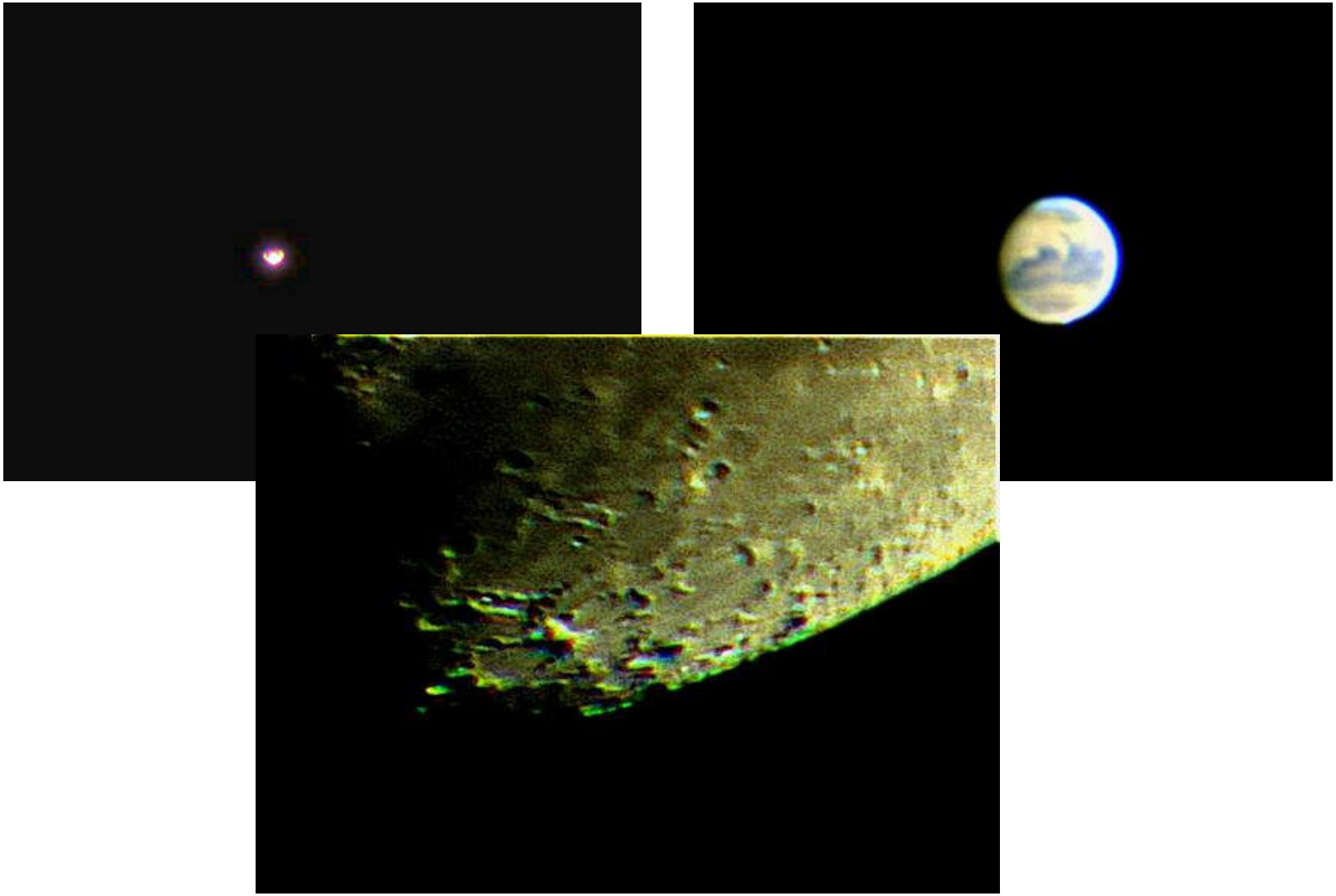



WILLIAM OPTICS USA
Fully Multi
Megrez 80E SEMI-APO
f=480 mm D:80 mm
STM-Cooled
WILLIAM OPTICS USA

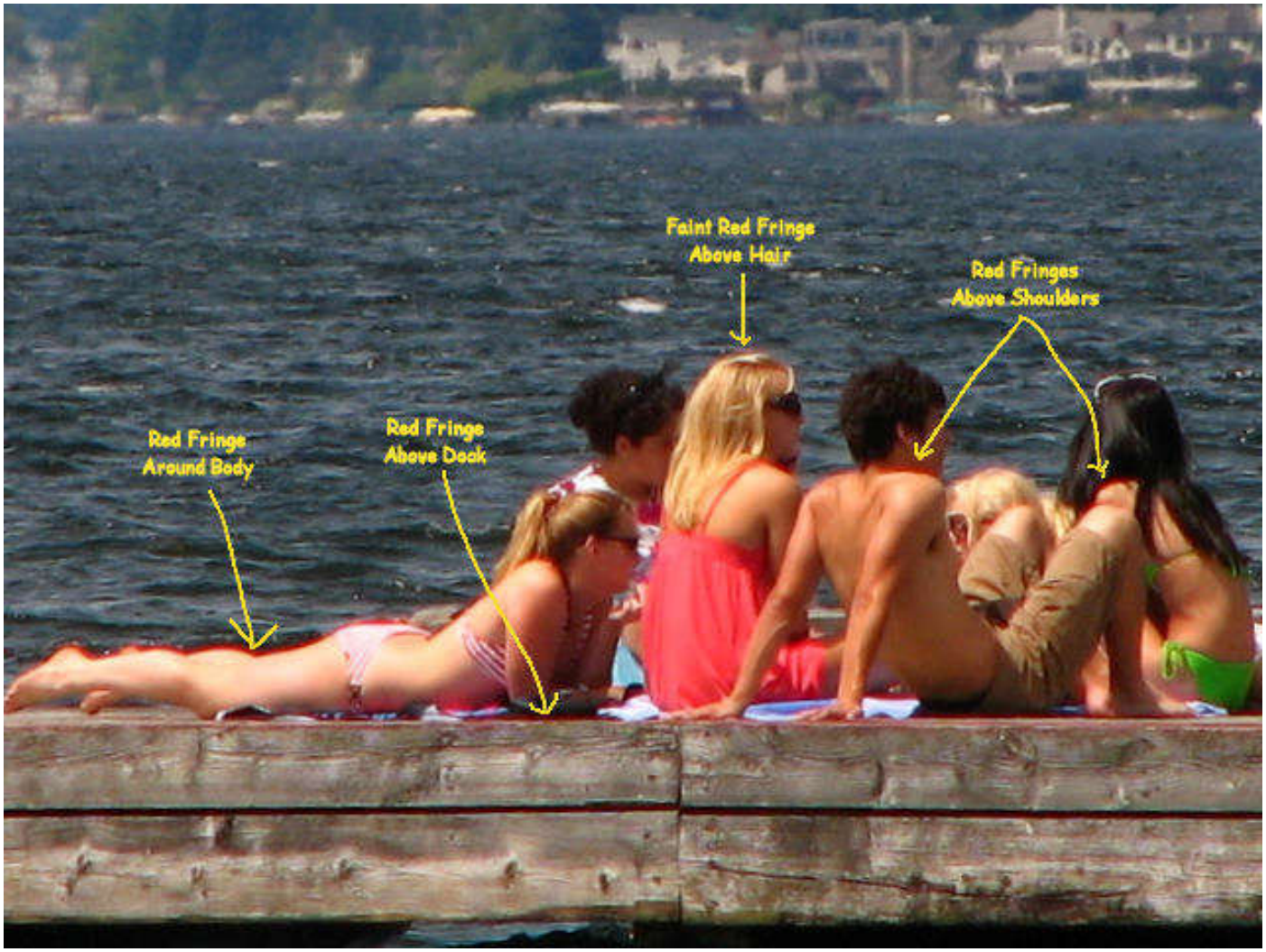
What are the other uses of coatings?

- Optical coatings are also used to:
  - Hide optical limitations in design and manufacturing
    - Chromatic aberration
    - Glare
  - Remove/filter out unwanted effects
    - Light pollution and sky glow
    - Chromatic aberration
  - Improve light transmission
    - Filters
    - Barlow lenses

Examples of chromatic aberration

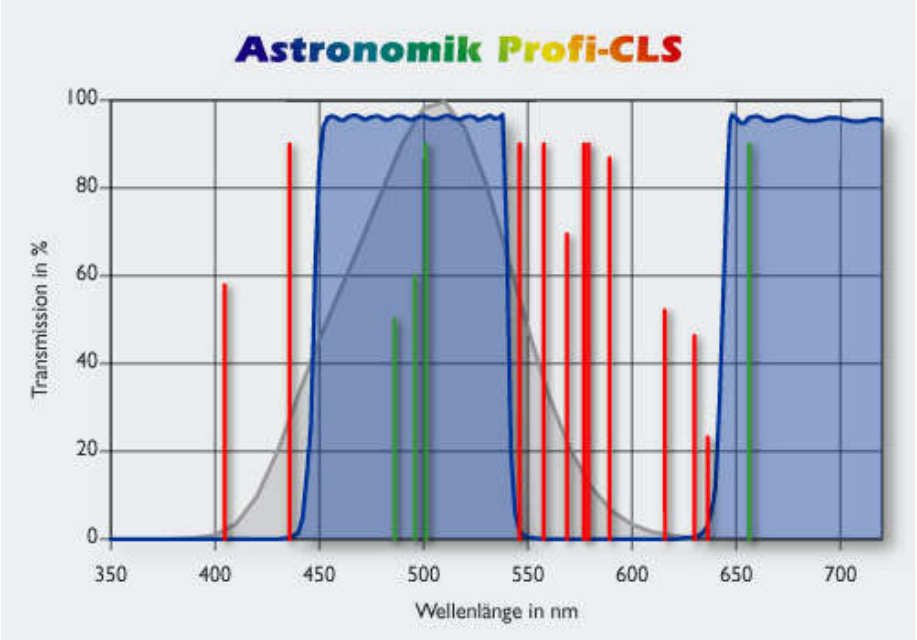


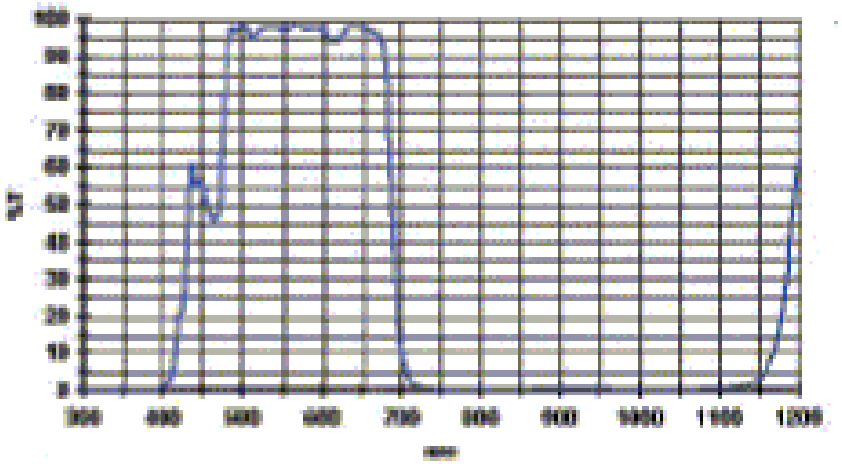
More examples of chromatic aberrations (on other forms of heavenly bodies)



Is there a solution?

- High F/# (size)
- Viewing/imaging in narrow band
- Filter out undesirable wavelengths while passing through desirable wavelengths
  - Material choice
  - Coatings





How to test your eyepiece's coatings

- Stand in a place where a bright light can shine over your shoulder. (With better alignment you can see reflections from deeper surfaces)
- Orient the eyepiece until you can observe a number of reflections from the eyepiece.
  - The number of reflections is an indication of the complexity of the eyepiece
  - The brightness of the reflections is an indication of the losses
    - Also look at the colour of the reflections since reflections from flat surfaces will seem bright even though it may have good coatings applied
- View into the eyepiece to see the apparent field of view

Acknowledgements

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- Questions