Narrowband Filters

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Topics

• What is Narrowband Imaging?
• Narrowband Filters
• Benefits
• Selection
Broadband Objects

- Galaxies
  - NGC253
- Star Clusters
  - 47Tuc
- Reflection Nebulae
  - NGC1579

Emit light over a continuum of wavelengths
Narrowband Objects

Emission Nebulae

Planetary, Wolf-Rayet Nebulae

Supernova Remnants

Emit light at discrete wavelengths due to ionization from nearby UV stars
What is Narrowband?

Photometric Red
(Photometric Red)

Imaging Red
(Imaging Red)

OIII

H-alpha

SII

Bandwidth
120 nm
80 nm
5 nm

500  600  700
Wavelength (nm)

Photometric Red
(UVBRI)

Imaging Red
(RGB)

H-alpha

H-alpha
Narrowband Filter

For highest contrast:

1. Highest transmittance
2. Smallest bandwidth

Background ADU count scales with FWHM
How NB Filters Are Made

Substrate

Blocking Layer

BandPass Layer

Result

%T

%T

%T

%T

Transmittance (%) vs Wavelength (nm)
Close-Up of Narrowband Filter

H = High refractive index layer (e.g., 2.3)
L = Low refractive index layer (e.g., 1.45)

\[ N_e = \text{effective index of layer} = \sqrt{H \times L} = 1.8 \] (affects blue shift)
Benefits of NB Imaging

- Enhance contrast
- Use in light polluted areas
- Emphasize different structures H-a, OIII, SII
- Extend imaging time when the moon is up
Moonlight & Light Pollution

Photometric Red
Imaging Red
H-alpha
SII

OIII
H-alpha
SII

5750 Blackbody

Normalized Units

Wavelength (nm)

500 600 700 800

Normalized Units

Wavelength, nm

400 500 600 700 800

Incandescent, Outdoor Flood Lamp
Fluorescent, Hg
Sodium Street Lamp

OIII
H-alpha
SII
Contrast Improvement

Crescent Nebula, Wolf-Rayet Bubble in Cygnus, NGC 6888

Wide Red (Orange)  Narrow Red  H-α  9 nm  H-α  6 nm  H-α  4 nm

3x5min exposures, RCOS 12.5” Ritchey-Crétien, SBIG STL11000XM CCD, Bisque Paramount ME
Enhanced Structure at Hi-Res

Crescent Nebula in Cygnus, NGC 6888

Conventional RGB
(courtesy Rob Gendler)

Red = H-α
Blue=Green=OIII
(Don Goldman)
Comparison of 3 vs 6 nm OIII

- 20” RC
- Full Moon
- Background ADU decreased from 5,700 to 1,800
- Gradient gone
- Smaller stars
- Greater faint detail
- Moonlight strongest at OIII

Data provided by Ken Crawford
Effect of Faster Optics (Blueshift)

- %T at emission line most important
- 5 and 3 nm NB >90%T f/10 – f/3.5
- 5 nm OIII, H-a >90%T f/3; SII > 83%
- 3 nm OIII >90%T f/3, H-a, SII >80%T
- Telescope optics reduce loss
- Can expect >90%T for all filters
- ASTRODON NB FILTERS CAN BE USED TO F/3
H-a Comparison Fast Optics

Epsilon-180 at f/3

5nm

3nm

SBIG STL11000XM, -25C, 10 min unbinned exposure, calibrated (dark, flat, bias), equalize screen stretch in MaximDL, Takahashi Epsilon-180 at f/3

HyperStar on C14, f/2

3nm

20-minute uncalibrated exposure, QSI583, C14 with Hyperstar at f/2 from Gary Gonella
Thank You!!
Clear Skies