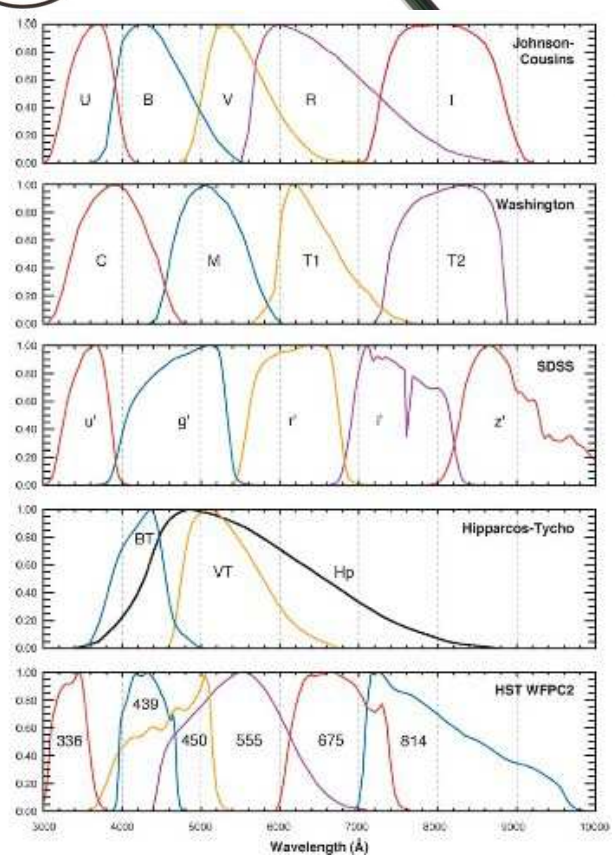
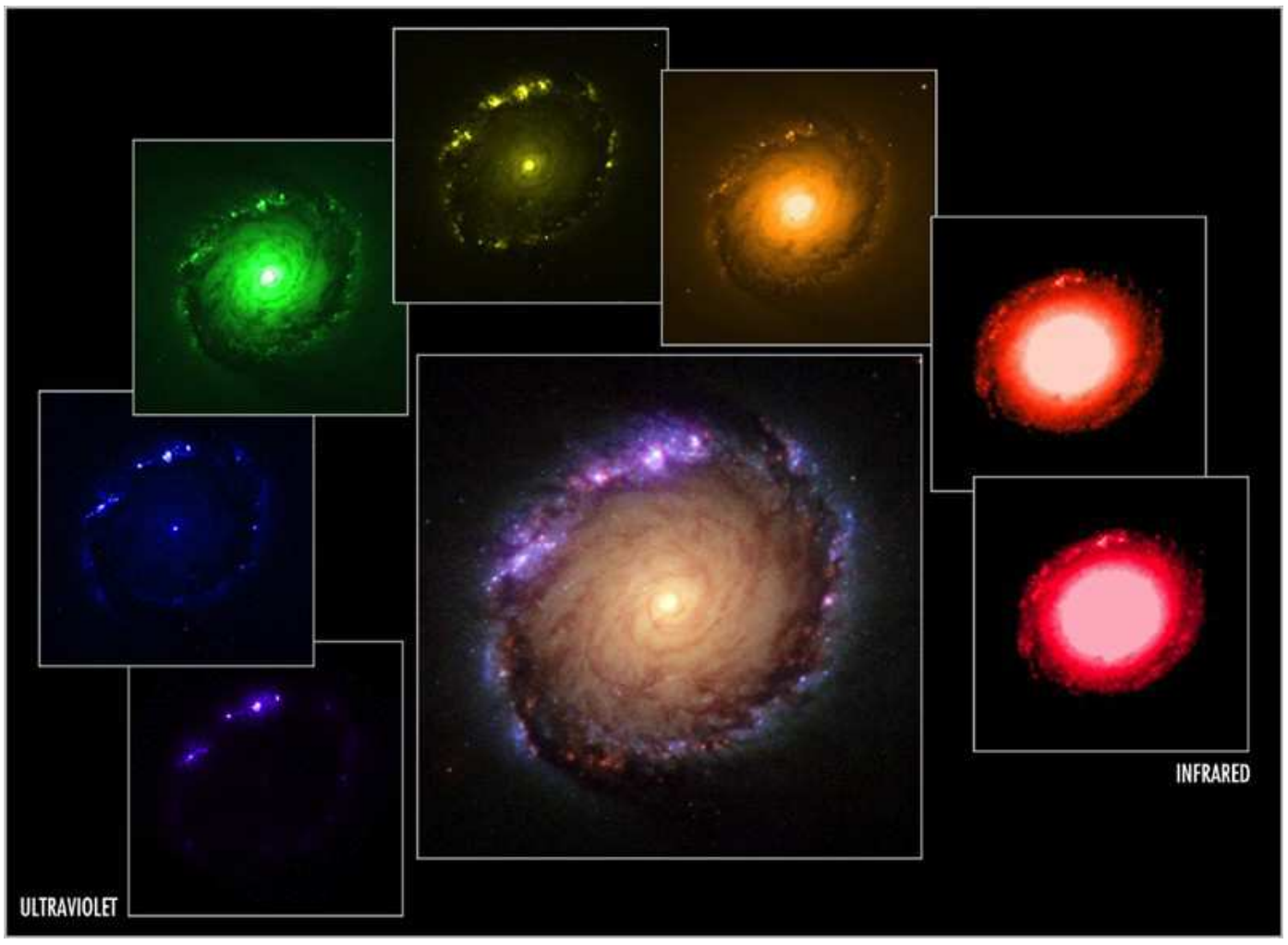
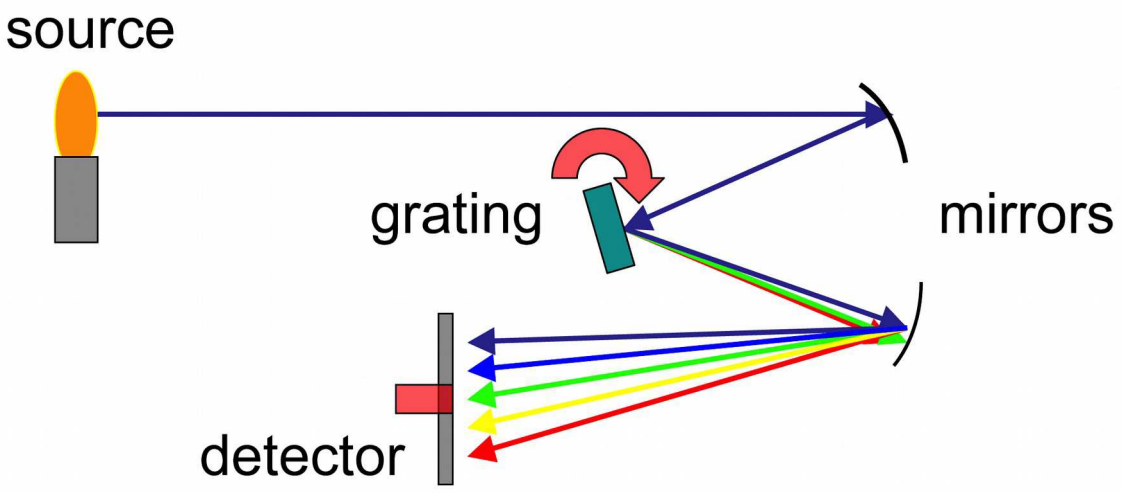
ASTRONOMY TECHNIQUES

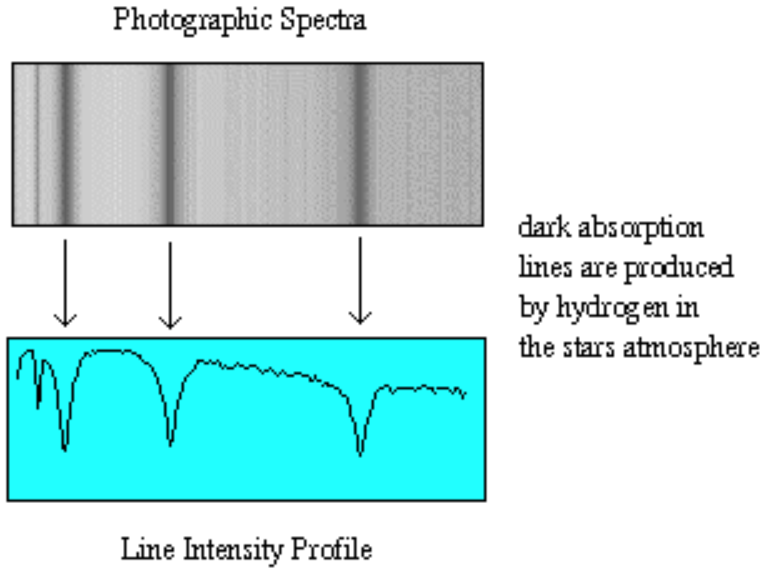
PHOTOMETRY WITH FILTERS

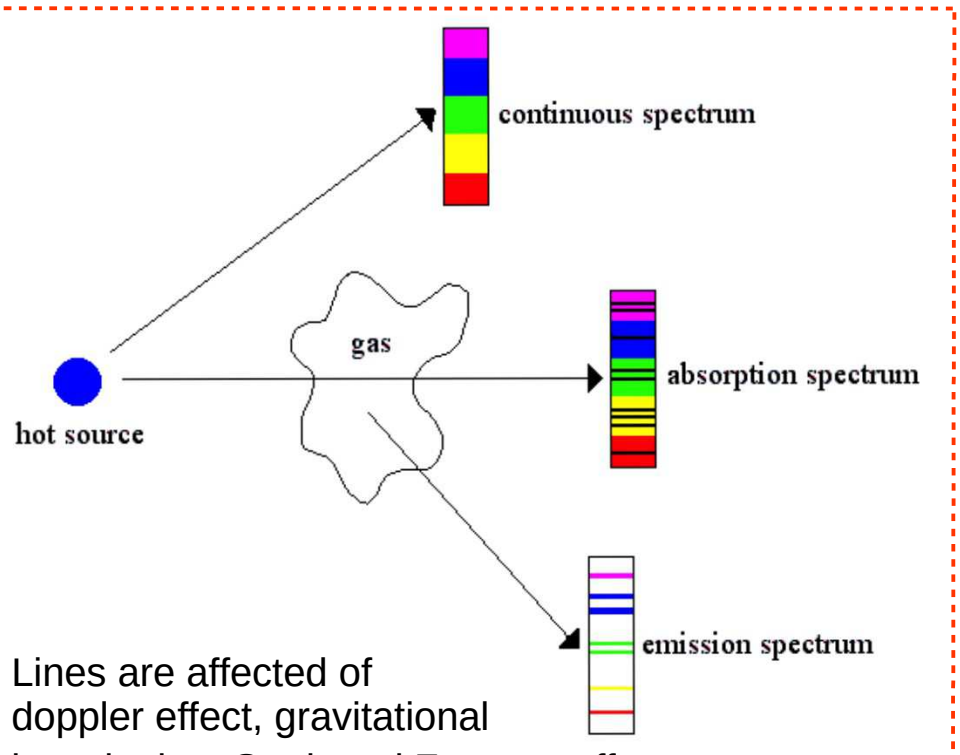




SPECTROSCOPY

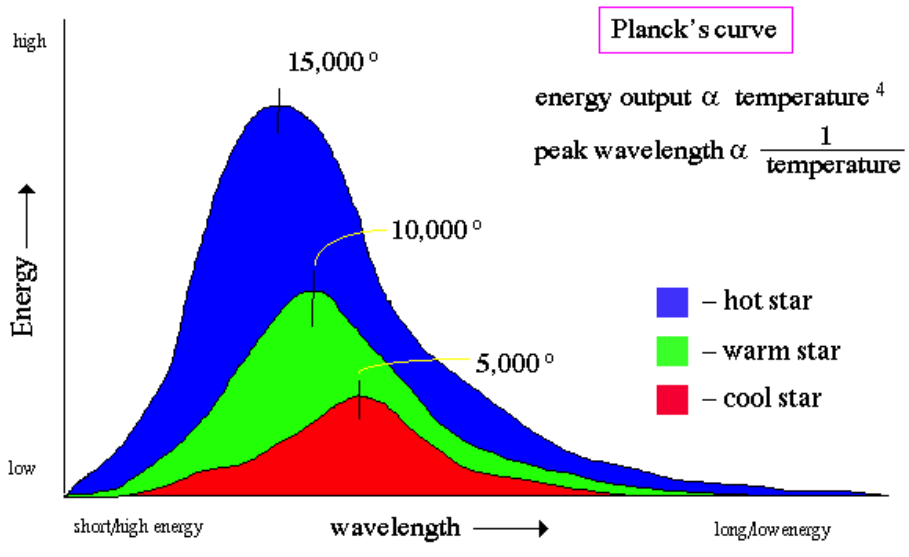




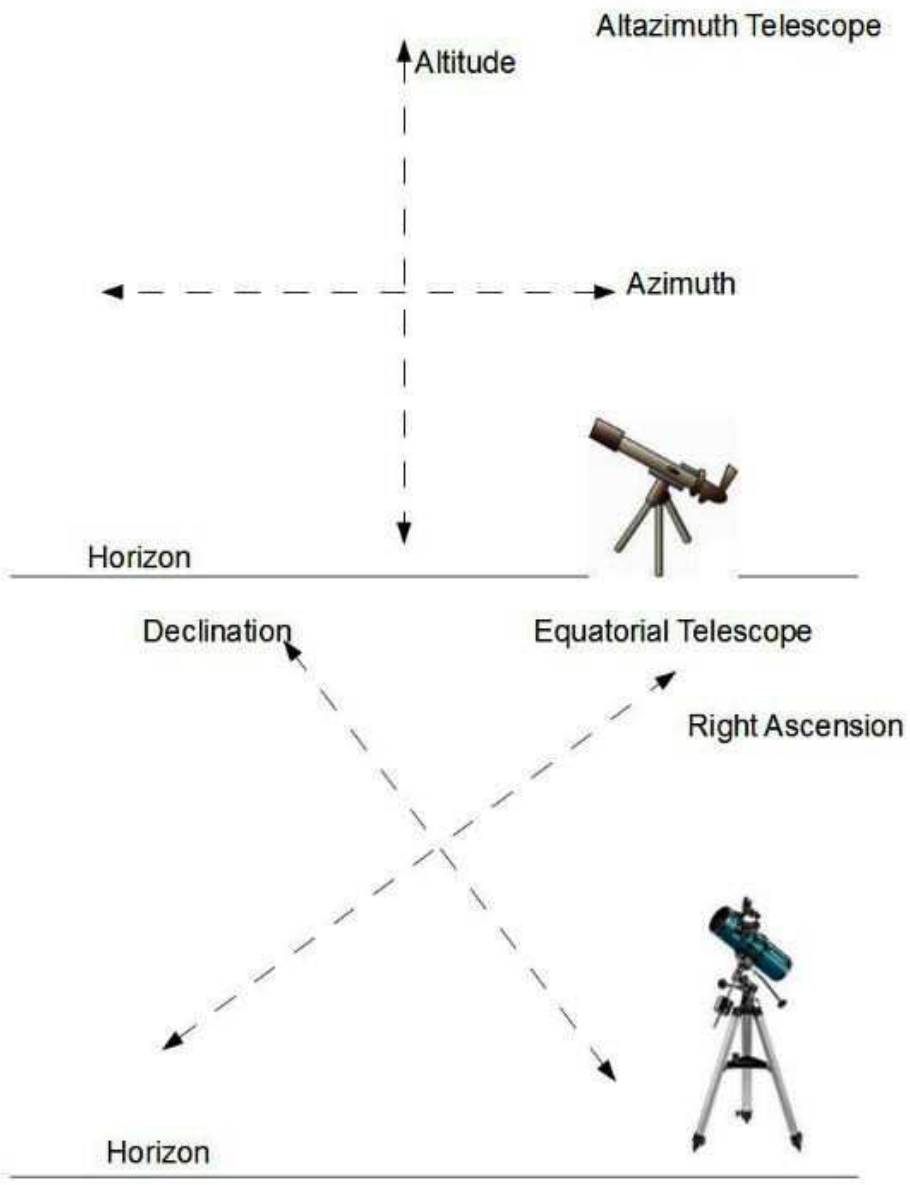


Lines are affected of doppler effect, gravitational broadening, Stark and Zeeman effects...

SPECTRAL LINES



ASTRONOMICAL MOUNTS



SOME PRACTICAL OPTICS...

Our Schmidt-Cassegrain telescope is a 35.6cm diameter f/10. The apparent field of the eyepieces we have is ~50-56 degrees, giving FoV from 6 to 33 arcsec.

$$Number\ f\ .\because = \frac{Focal\ distance}{Diameter}$$

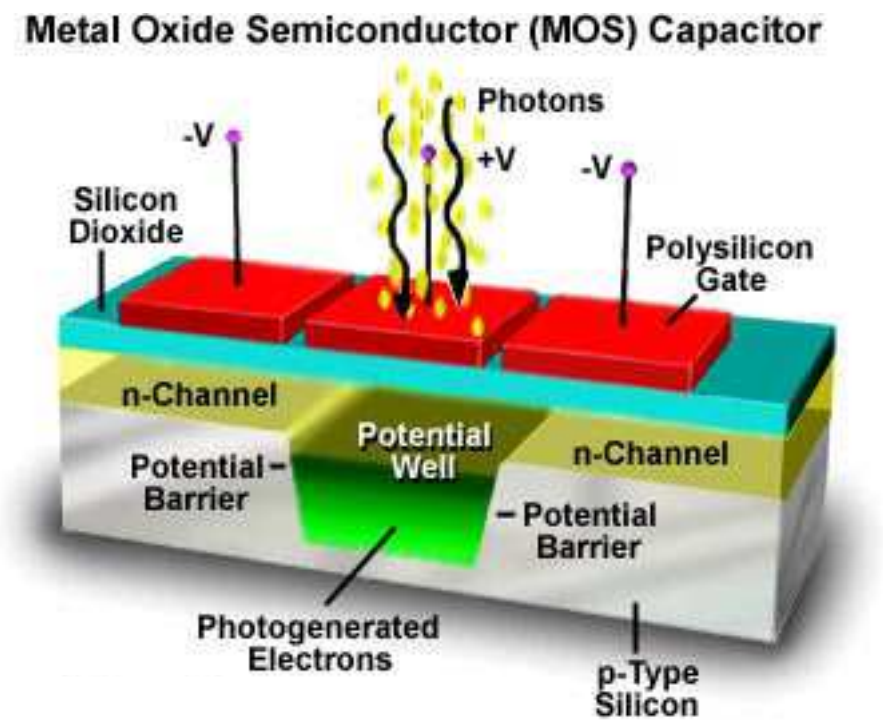
$$Resolving\ power\ R[^o] = \frac{115}{Diameter[mm]}$$

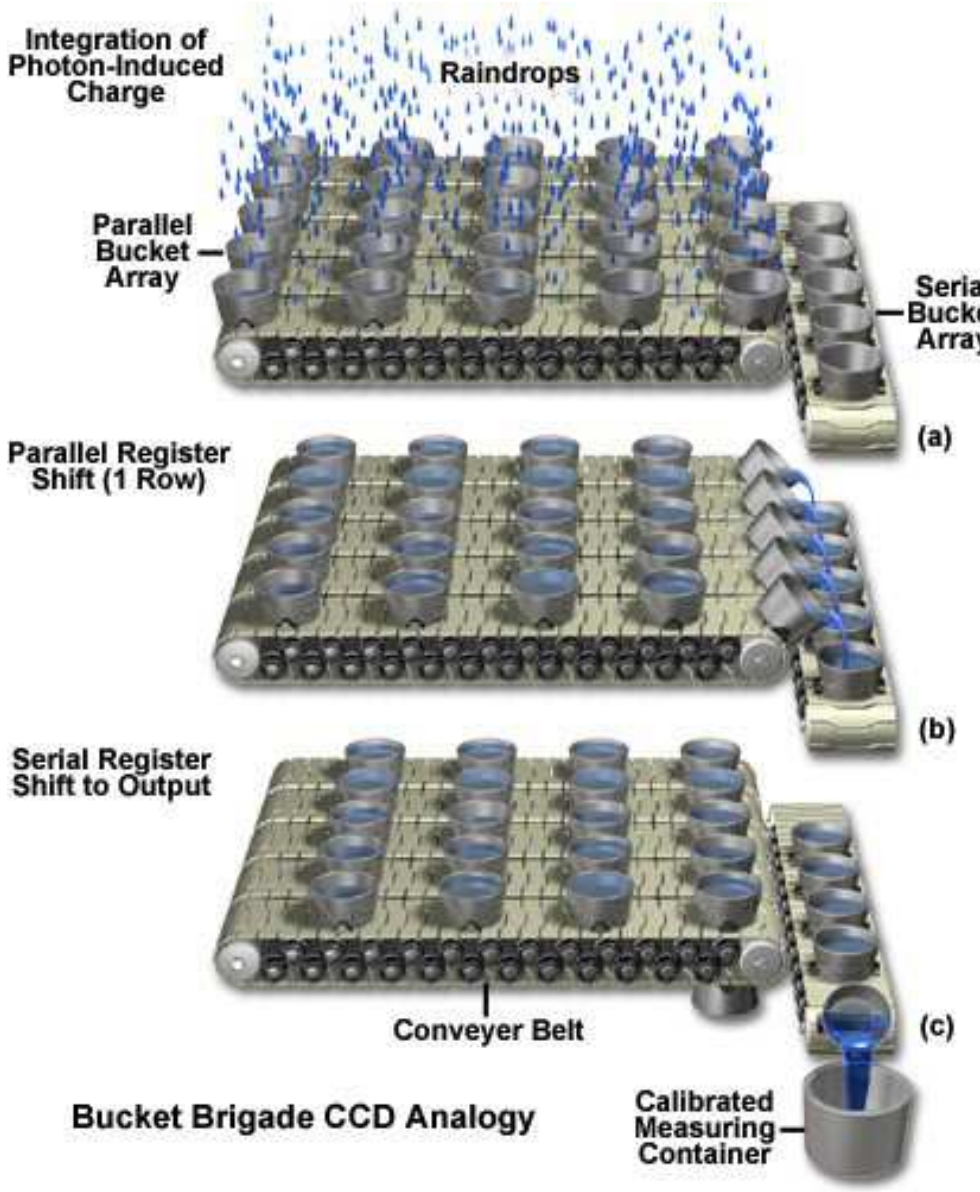
$$Magnification\ X = \frac{Focal\ telescope}{Focal\ oculair}, \qquad max.2 \times D[mm]$$

$$Fiew\ FoV[^o] = \frac{60 \times Oculair\ apparent\ field[^o]}{Magnification}$$

$$Pupil\ P = \frac{Focal\ oculair}{f\ .\because} \leq 5\,mm$$

CCD CAMERAS

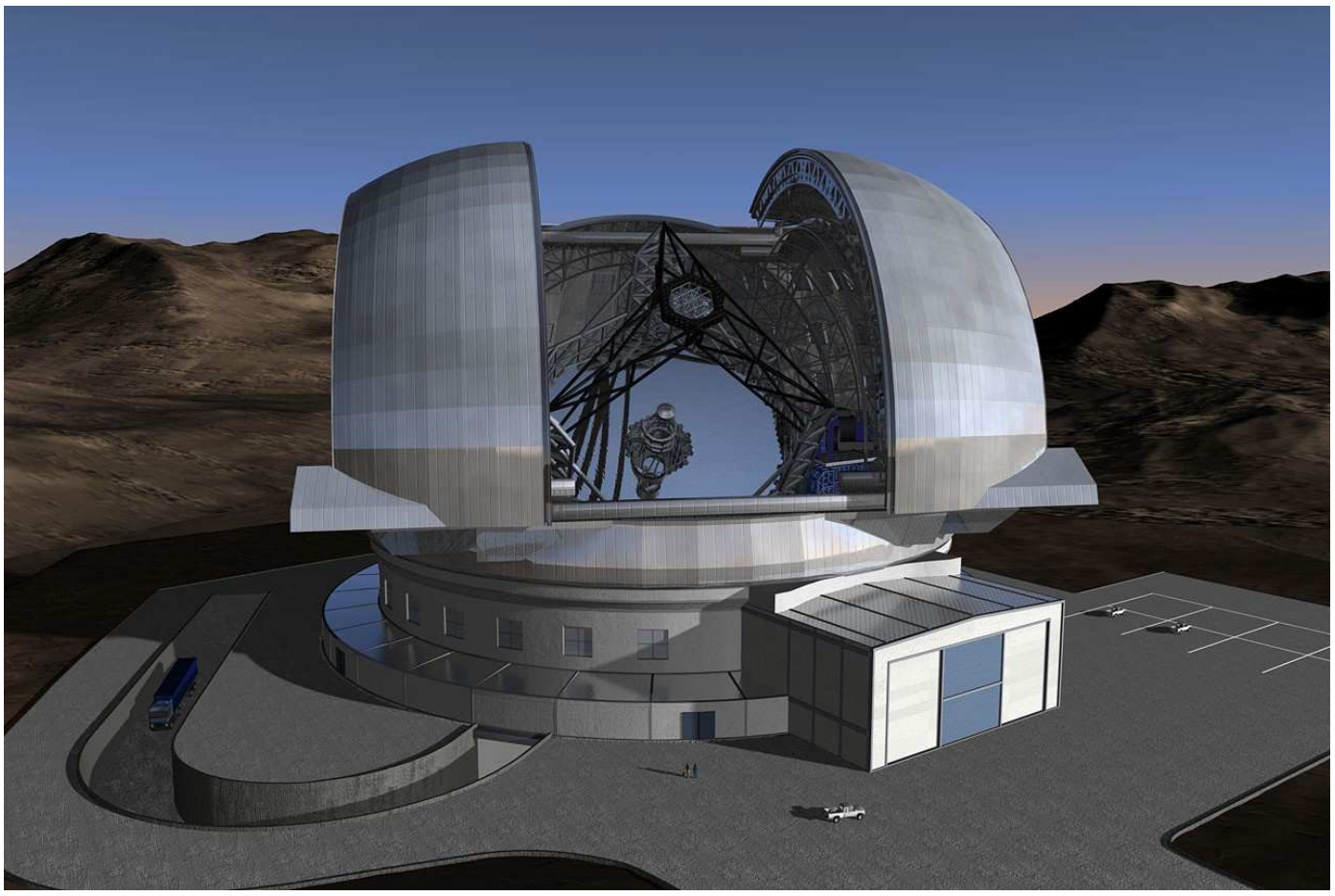




CALIBRATION OF CCD IMAGES

- Bias level
- Dark current
- Flat field

EUROPEAN EXTREMELY LARGE TELESCOPE (E-ELT)



Great Paris Exhibition Telescope
(lens at the same scale)
Paris, France (1900)

Yerkes Observatory
(40" refractor lens at the same scale)
Williams Bay, Wisconsin (1893)

Hooker (100")
Mt Wilson, California (1917)

Hale (200")
Mt Palomar, California (1948)

(1979-1998) (1999-)
Multi Mirror Telescope
Mount Hopkins, Arizona

BTA-6 (Large Altazimuth Telescope)
Zelenchuksky, Russia (1975)

Large Zenith Telescope
British Columbia, Canada (2003)

Gaia
Earth-Sun L2 point (2014)

Kepler
Earth-trailing solar orbit (2009)

James Webb Space Telescope
Earth-Sun L2 point (planned 2018)

Hubble Space Telescope
Low Earth Orbit (1990)

Large Sky Area Multi-Object Fiber Spectroscopic Telescope
Hebei, China (2009)

Gran Telescopio Canarias
La Palma, Canary Islands, Spain (2007)

Keck Telescope
Mauna Kea, Hawaii (1993/1996)

Hobby-Eberly Telescope
Davis Mountains, Texas (1996)

Southern African Large Telescope
Sutherland, South Africa (2005)

Gemini North
Mauna Kea, Hawaii (1999)

Subaru Telescope
Mauna Kea, Hawaii (1999)

Thirty Meter Telescope
Mauna Kea, Hawaii (planned 2022)

Large Binocular Telescope
Mount Graham, Arizona (2005)

Gemini South
Cerro Pachón, Chile (2000)

Large Synoptic Survey Telescope
El Peñón, Chile (planned 2020)

Very Large Telescope
Cerro Paranal, Chile (1998-2000)

Magellan Telescopes
Las Campanas, Chile (2000/2002)

Giant Magellan Telescope
Las Campanas Observatory, Chile (planned 2020)

European Extremely Large Telescope
Cerro Armazones, Chile (planned 2022)

Human at the same scale

0 5 10 m
0 10 20 30 ft

Tennis court at the same scale

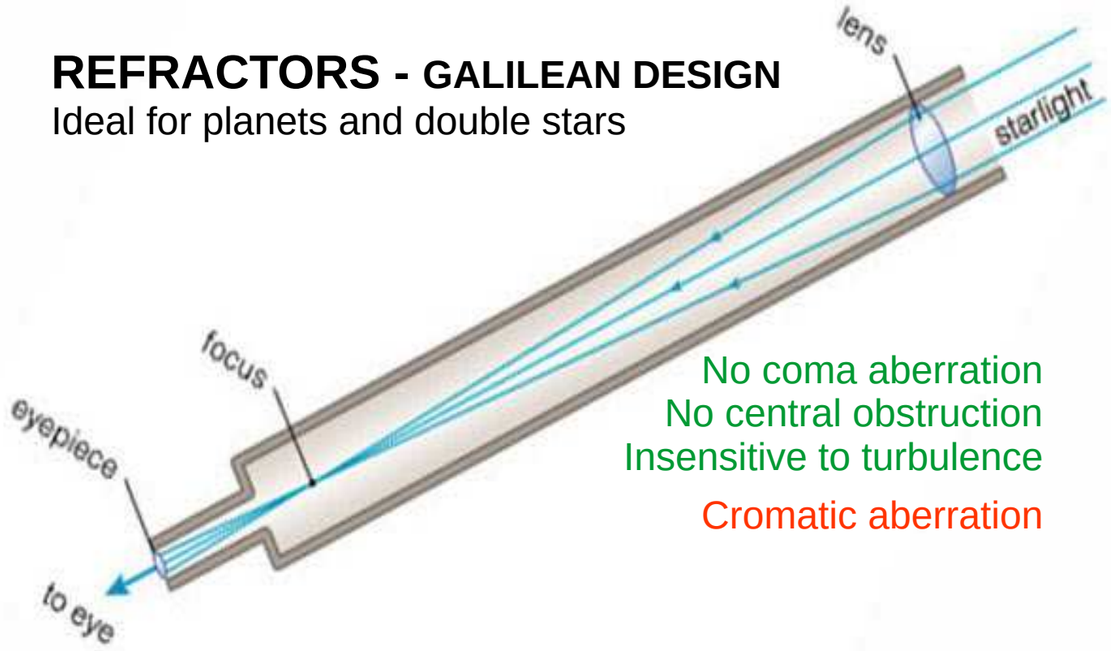
Overwhelmingly Large Telescope
(cancelled)
Arecibo radio telescope at the same scale

Basketball court at the same scale

OPTICAL TELESCOPES

REFRACTORS - GALILEAN DESIGN

Ideal for planets and double stars



No coma aberration
No central obstruction
Insensitive to turbulence

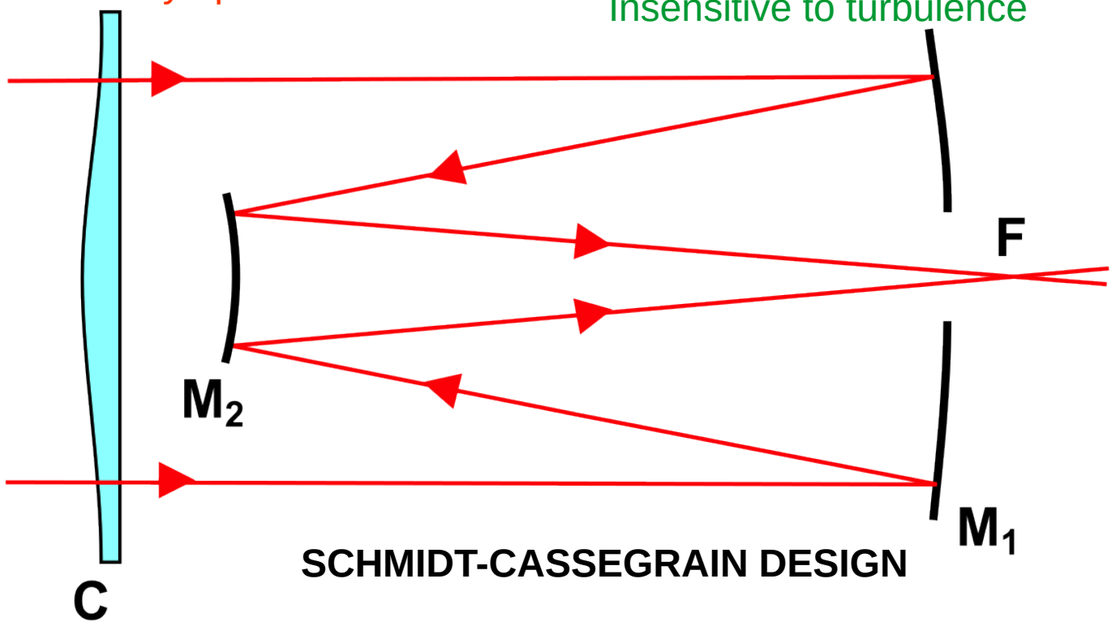
Cromatic aberration

CATADRIOPTRICS

Ideal for CCD observations and astrophotography

Great central obstruction
Many optical surfaces

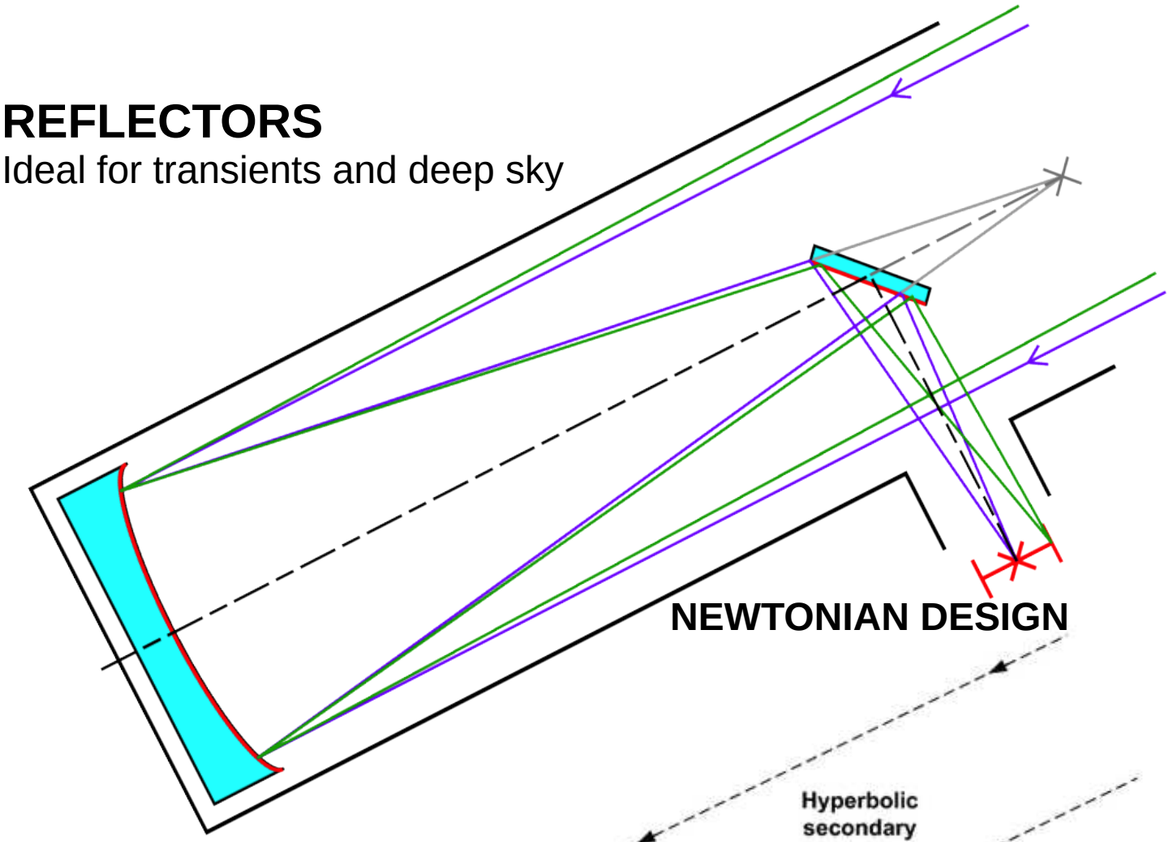
No cromatic aberration
No coma aberration
Insensitive to turbulence



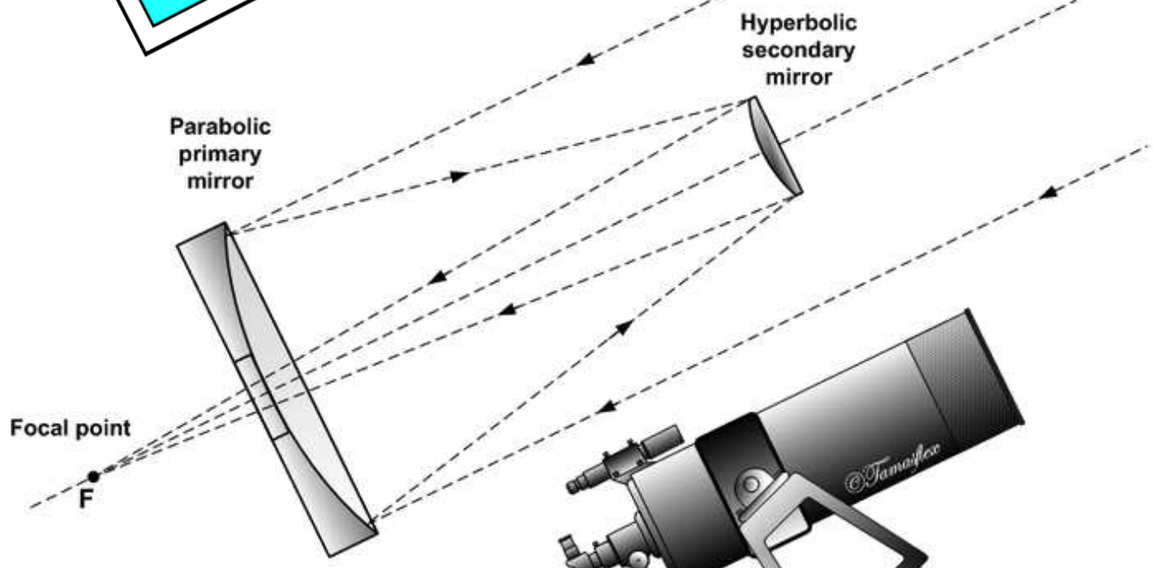
SCHMIDT-CASSEGRAIN DESIGN

REFLECTORS

Ideal for transients and deep sky

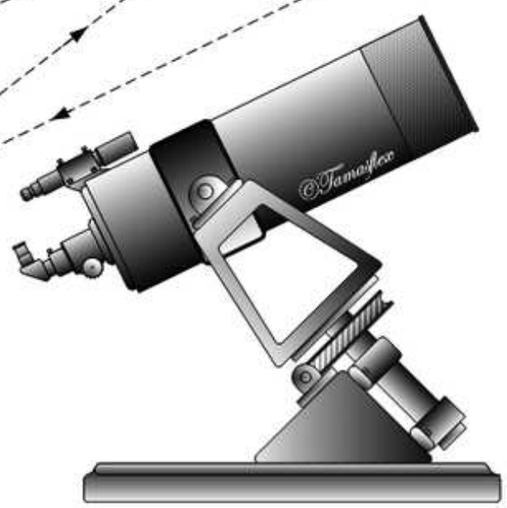


NEWTONIAN DESIGN



No cromatic aberration

Moderate central obstruction
Sensitive to turbulence
Coma aberration (esp. f/4)

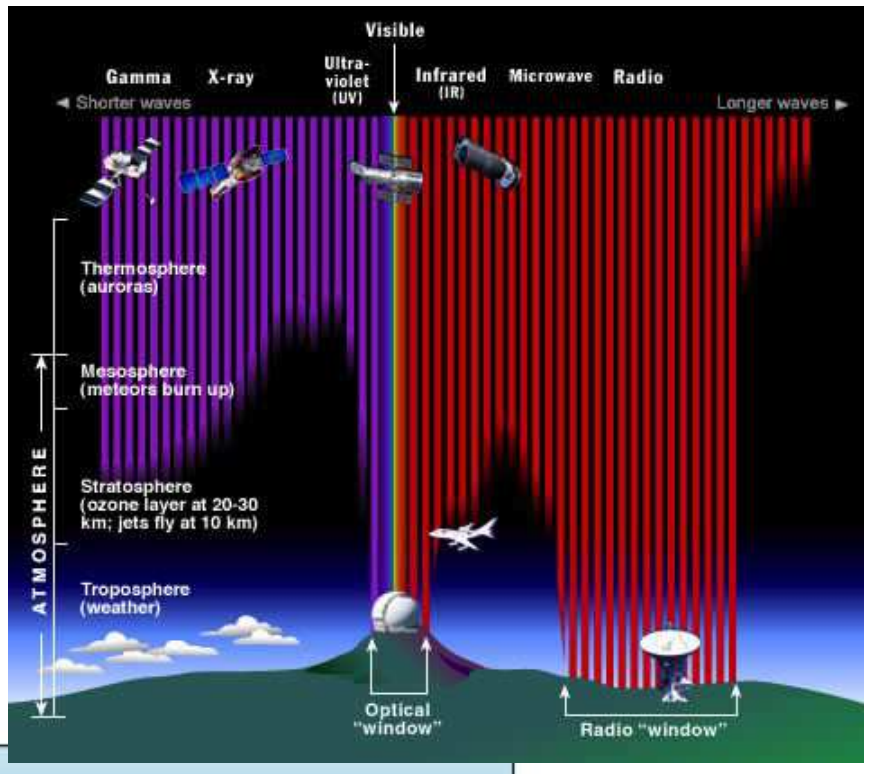


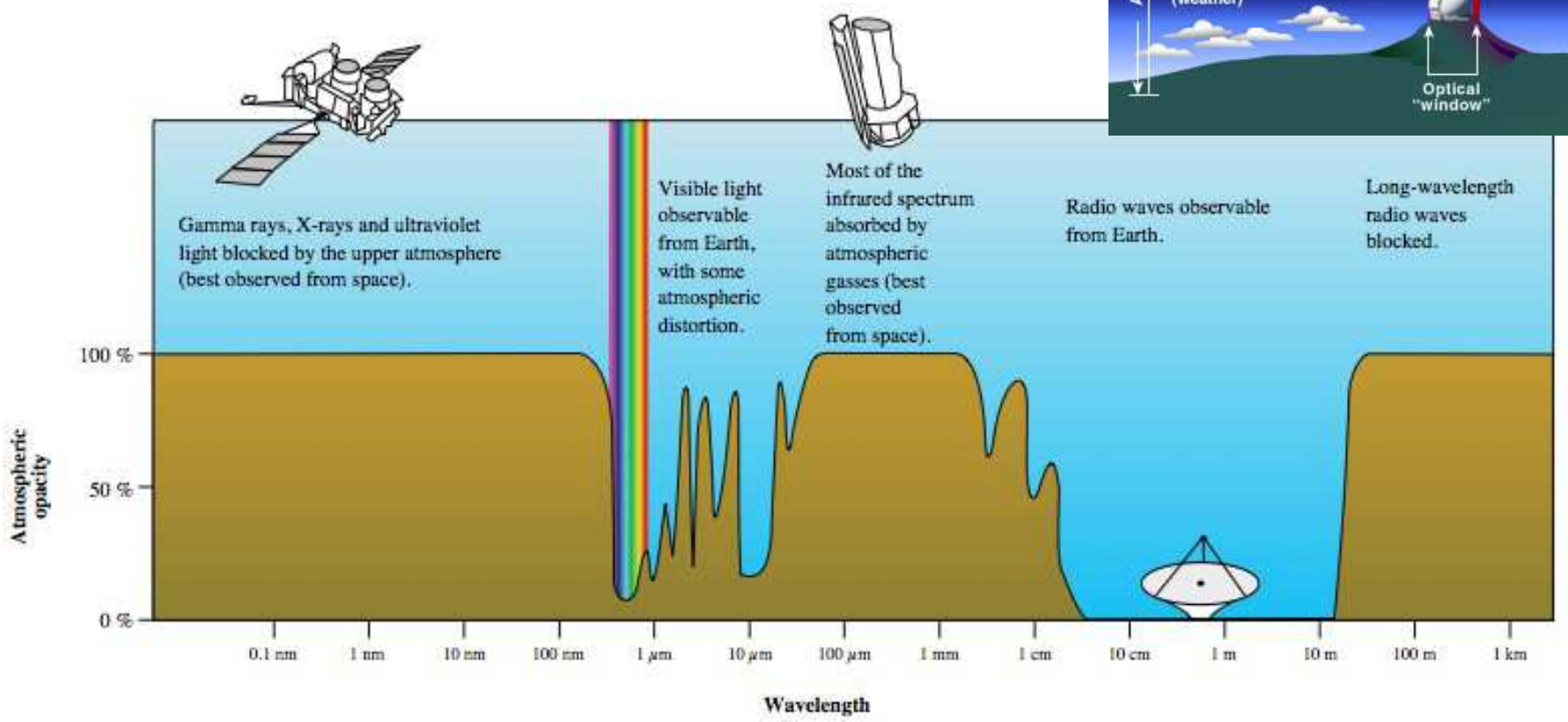
CASSEGRAIN DESIGN

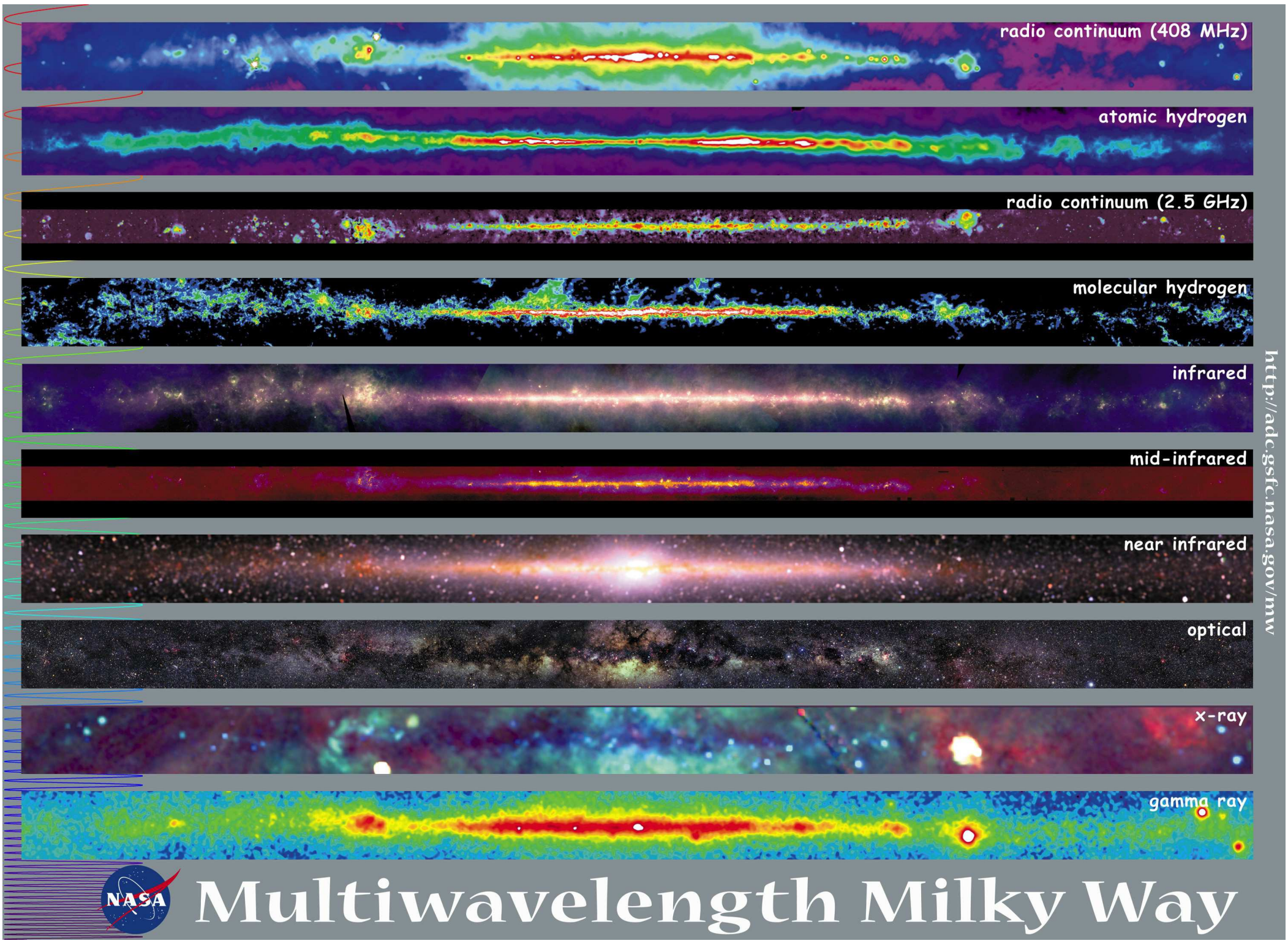
ELECTROMAGNETIC SPECTRUM

&

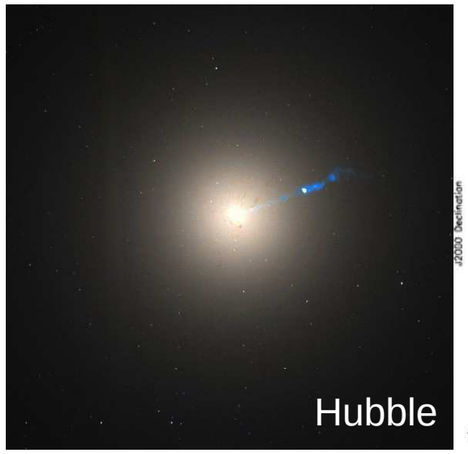
ATMOSPHERIC ABSORPTION

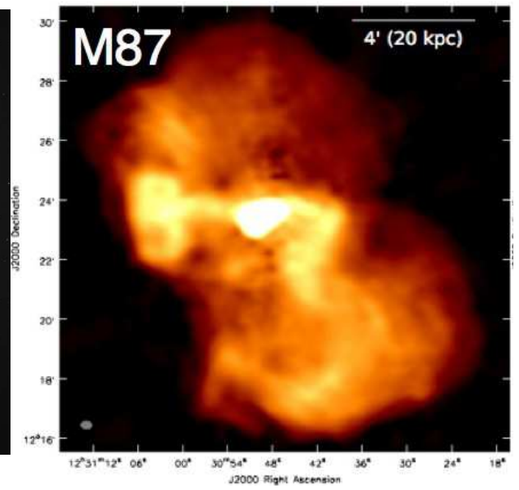




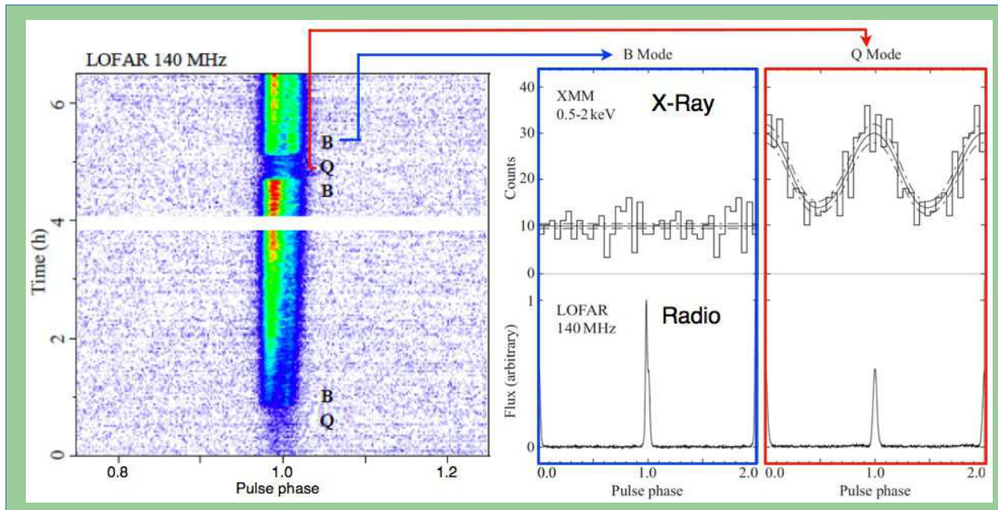


LOFAR

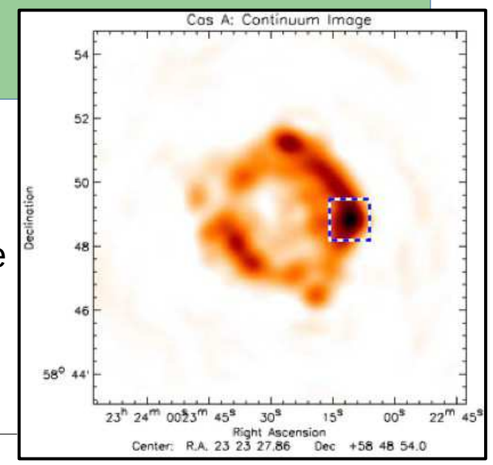




M87 is an extremely active radio galaxy in the Virgo cluster. With 140MHz images, jets are depicted and their properties Constrained. *Gasperin et al. 2012*.



The pulsar PSR B0943+10 exhibits bright and quiet radio modes that anticorrelate with X-ray emission. *Hermsen et al. 2013.*

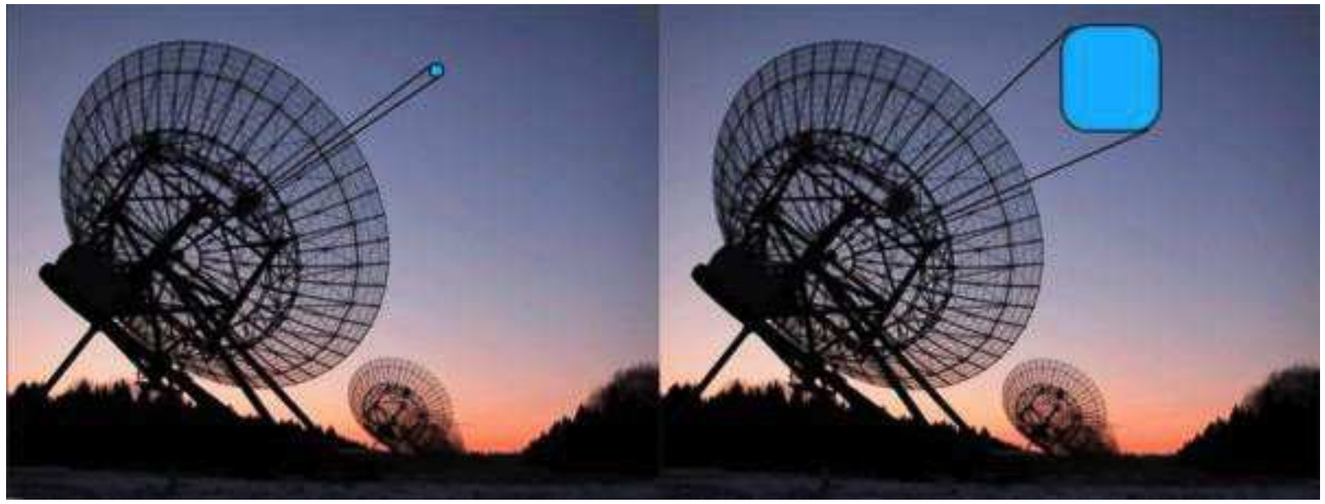


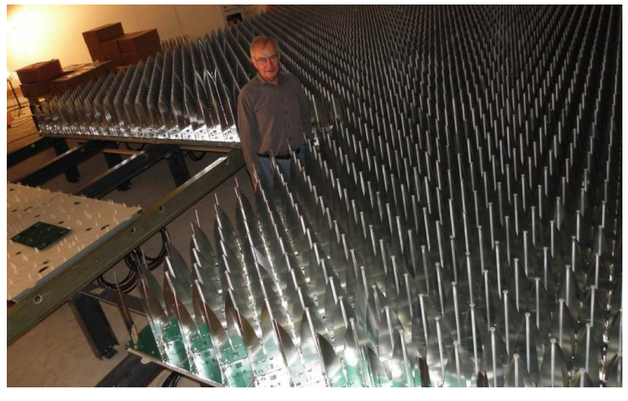
In the 52MHz image we see the carbon recombination line absorption distribution of the SNe remnant Cas A. *Akegar et al. 2013.*

WESTERBORK SYNTHESIS RADIO TELESCOPE

APERTIF

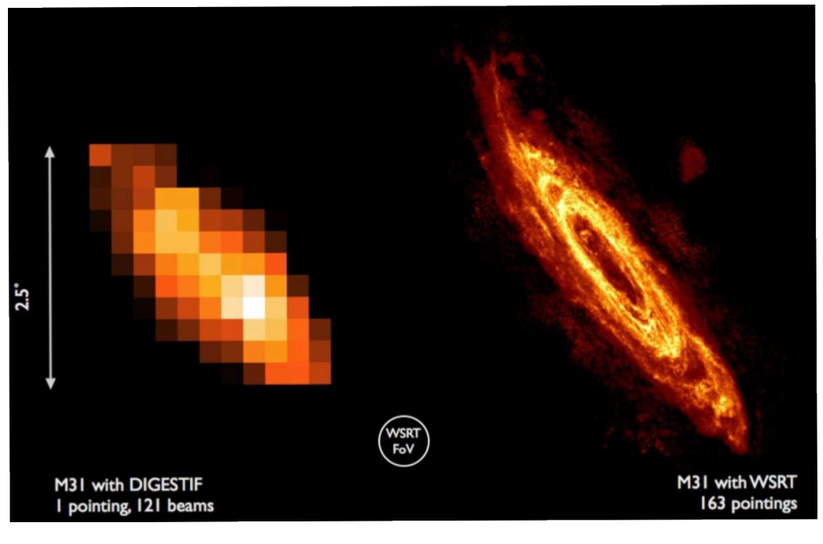
is an array of focal plane antennas that will increase the field of view of every radiotelescope a factor 25.





First image: The galaxy M31 as seen with WSRT.

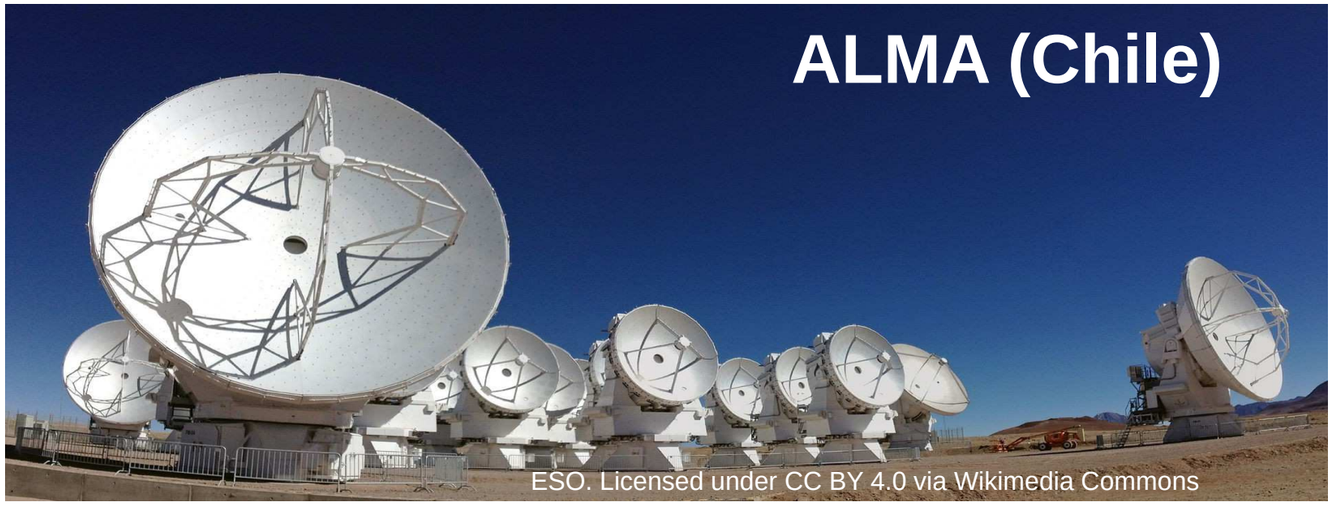
Left: 1 pointing of 1 telescope with APERTIF.
Right: 163 pointings of 14 telescopes w/out APERTIF

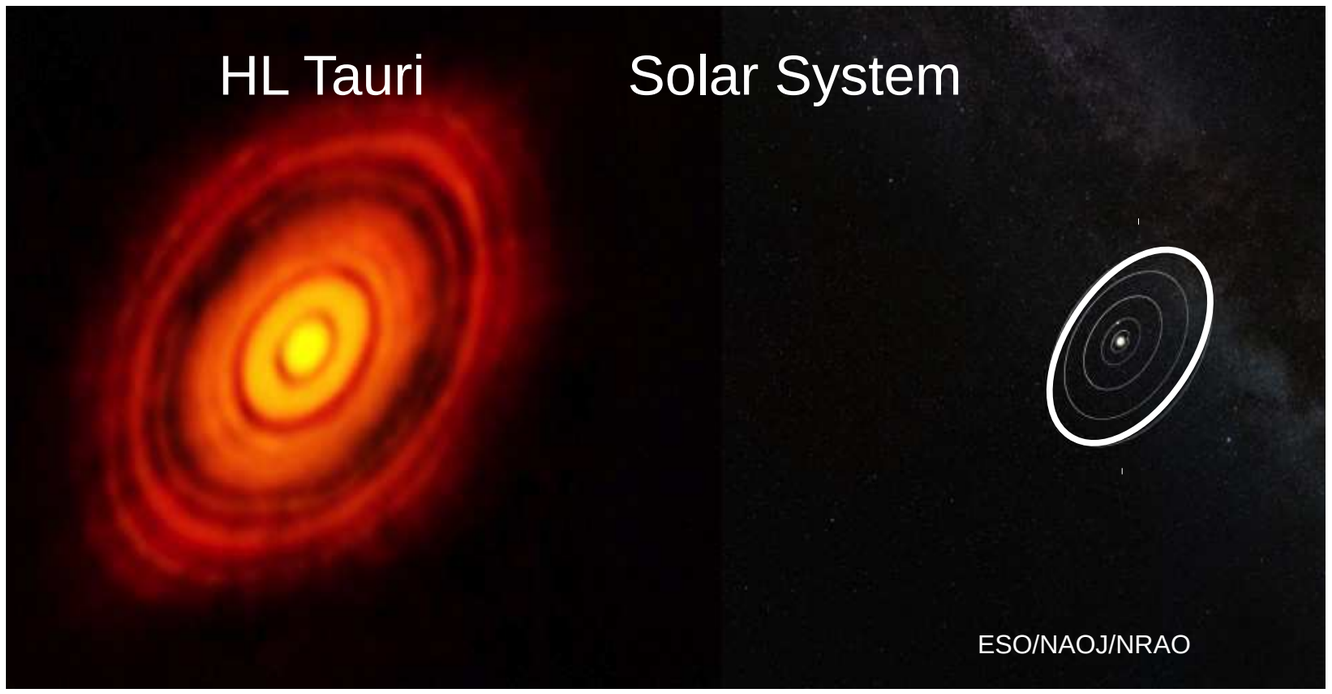


SCIENCE GOALS

Evolution of gas content of galaxies, Fast transients and pulsars, AGNs through continuum surveys, preparation for SKA...

PRESENT & FUTURE OF RADIOASTRONOMY





INTERFEROMETRY