(Astro)Physics 343 Lecture # 7:
Radio Telescopes etc.

Lab # 3: new data coming

Several (at least) of the datasets taken last week show little or no HI emission, possibly because of bad weather conditions (i.e., wet electronics) and/or instructor error.

You will receive new data this week. (If old data looked reasonable, then you can use them.) Please check the $b = 0$ scan before Friday!

Lab Report # 3 will now be due on Monday, March 31st.

Beware: radio frequency interference (RFI)!

Your data may show very narrow spike features in addition to the broad Galactic HI emission.

These are due to terrestrial sources, and should be noted and excluded from your analysis.

Why do we need telescopes?

If a simple dipole antenna can detect radio waves...

long-wavelength development array at VLA site (test bed for larger array with λ=0.3-30m)

Answer: collecting area (for short-wavelength observations).

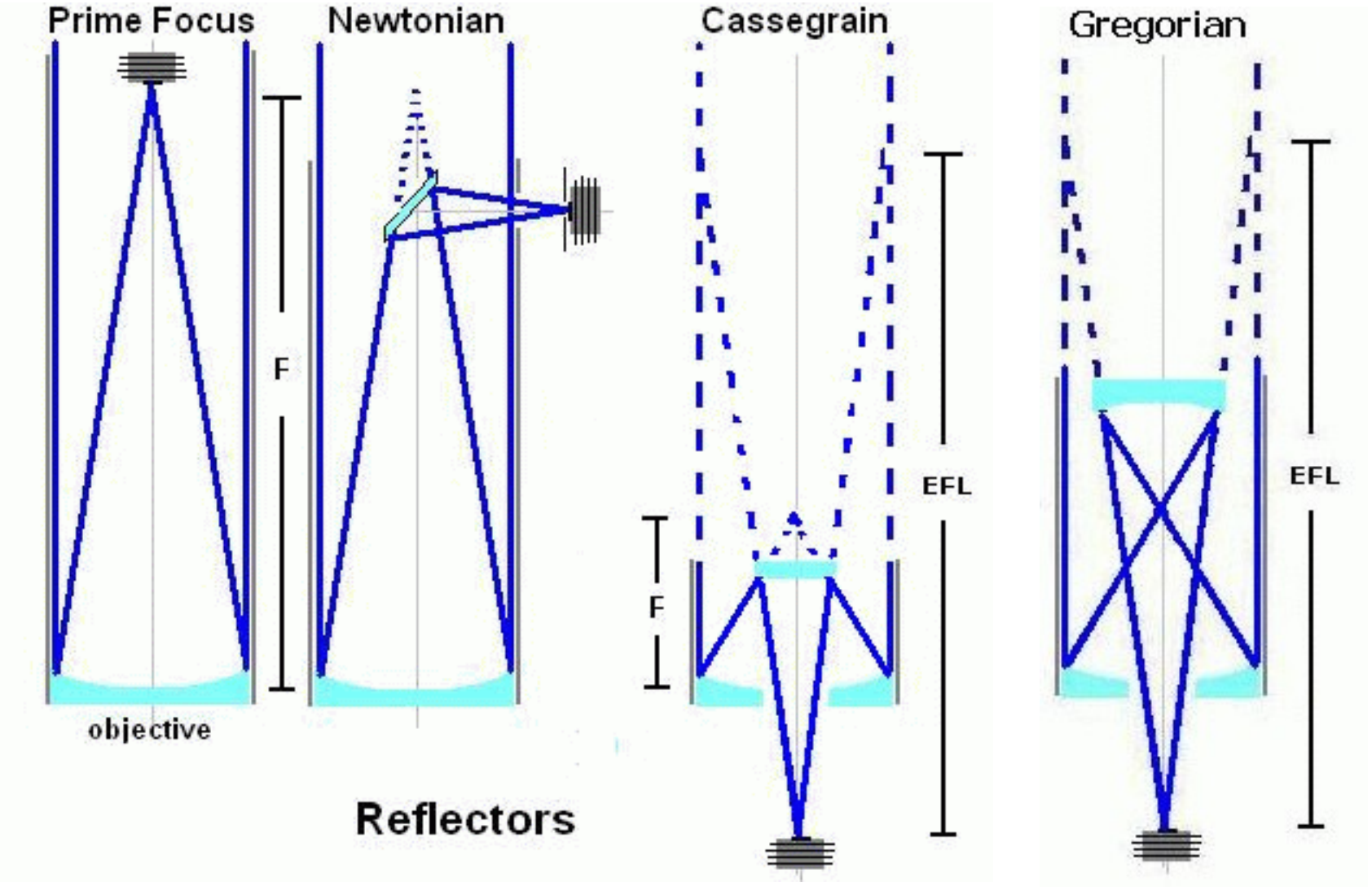
Telescopes collect and focus power onto a smaller (e.g., feed horn or dipole) antenna.

Telescope designs: feed horn vs. paraboloid

feed horns: response can be calculated a priori! but size limited...

paraboloid antennas: good for collecting area, calibration tricky

Telescope designs: location of foci

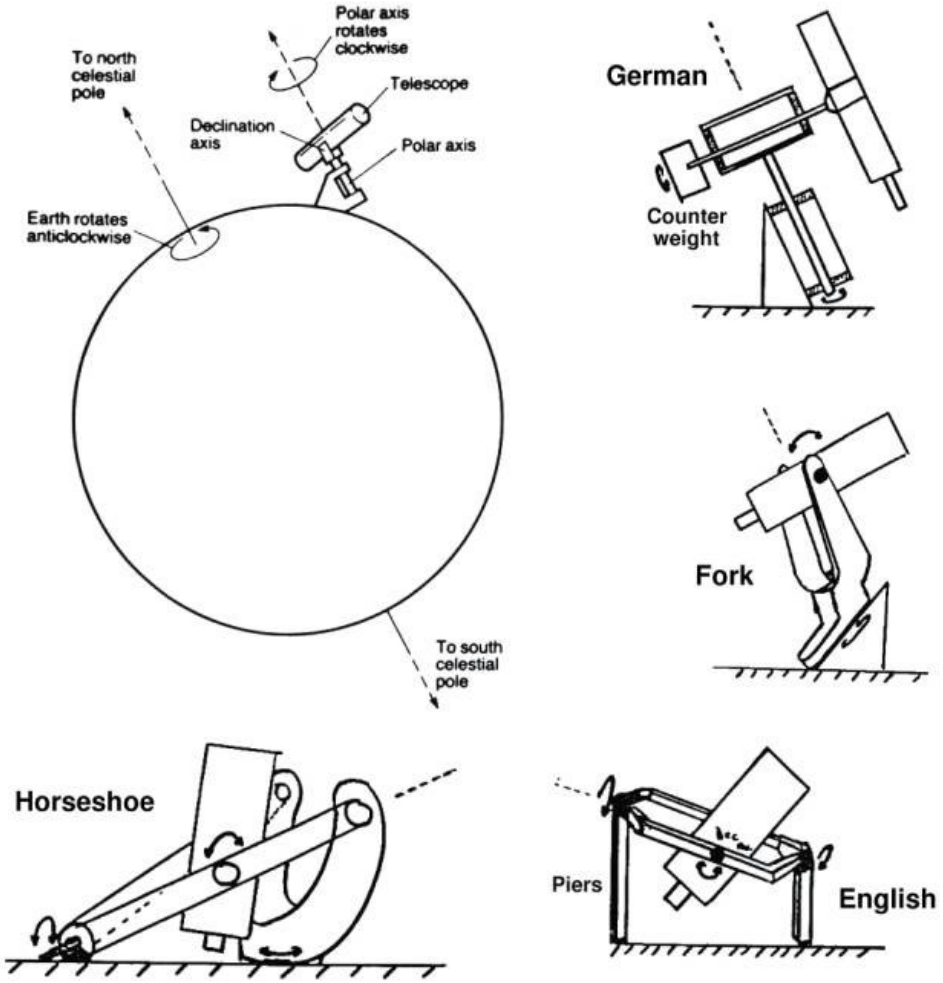


Borrowed from J. Oliver.

Telescope designs: on or off axis?

100m Effelsberg telescope (Germany) + Green Bank Telescope (WV)

Telescope designs: mount?



alt-az: both axes to track sources

equatorial: one axis to track sources

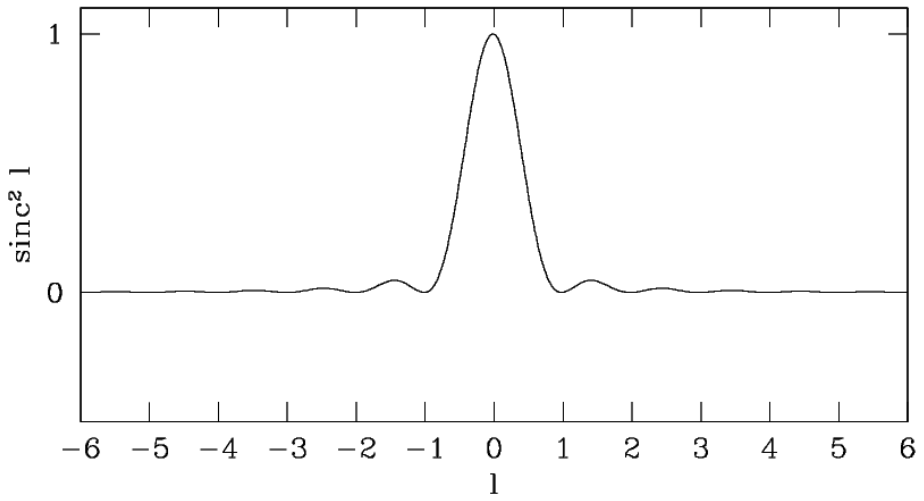
The last big scope with an equatorial mount

140 ft telescope at Green Bank:

(1) world's largest telescope with an equatorial mount

(2) contains world's largest ball bearing!

The (angular) resolution of a telescope



We know that the FWHM of the telescope's beam is proportional to λ/D.

By the Rayleigh criterion, this is also its resolving power: two point sources separated by the FWHM will sit on peak + first dip of response.

Radiometers

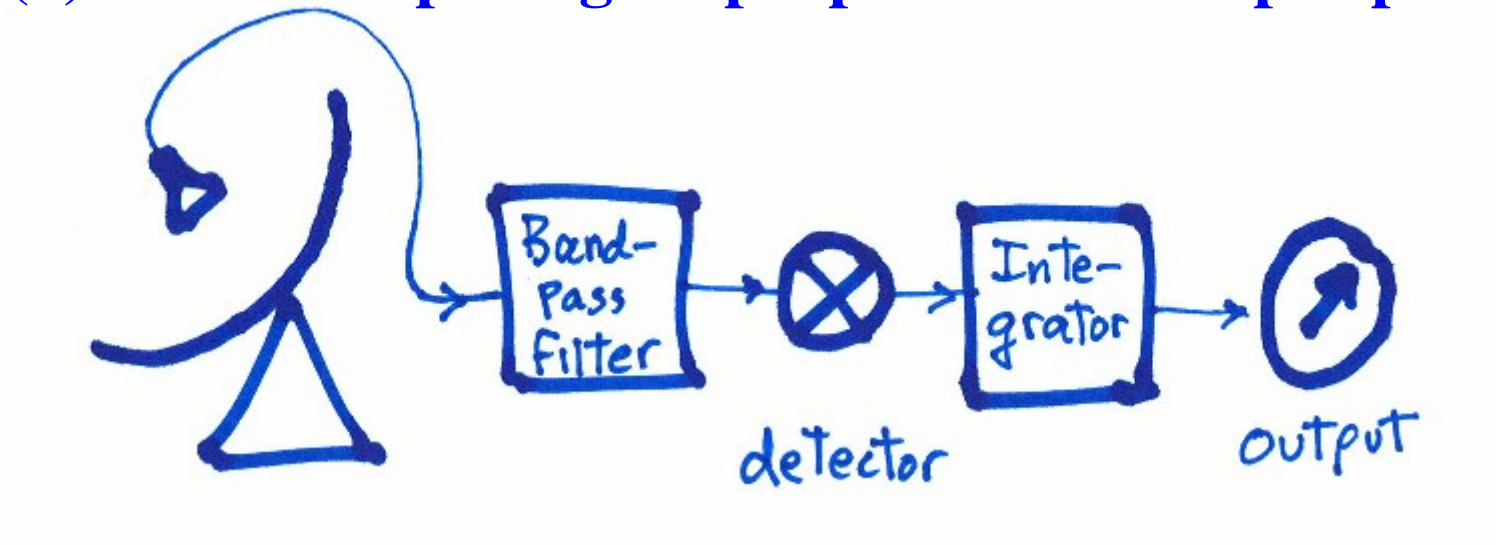
Steps in detection of radio emission with a radiometer:

(1) select a frequency bandpass

(2) multiply signal by itself

(3) integrate over some time interval

(4) record output signal proportional to input power



Borrowed from Condon & Ransom, ERA.

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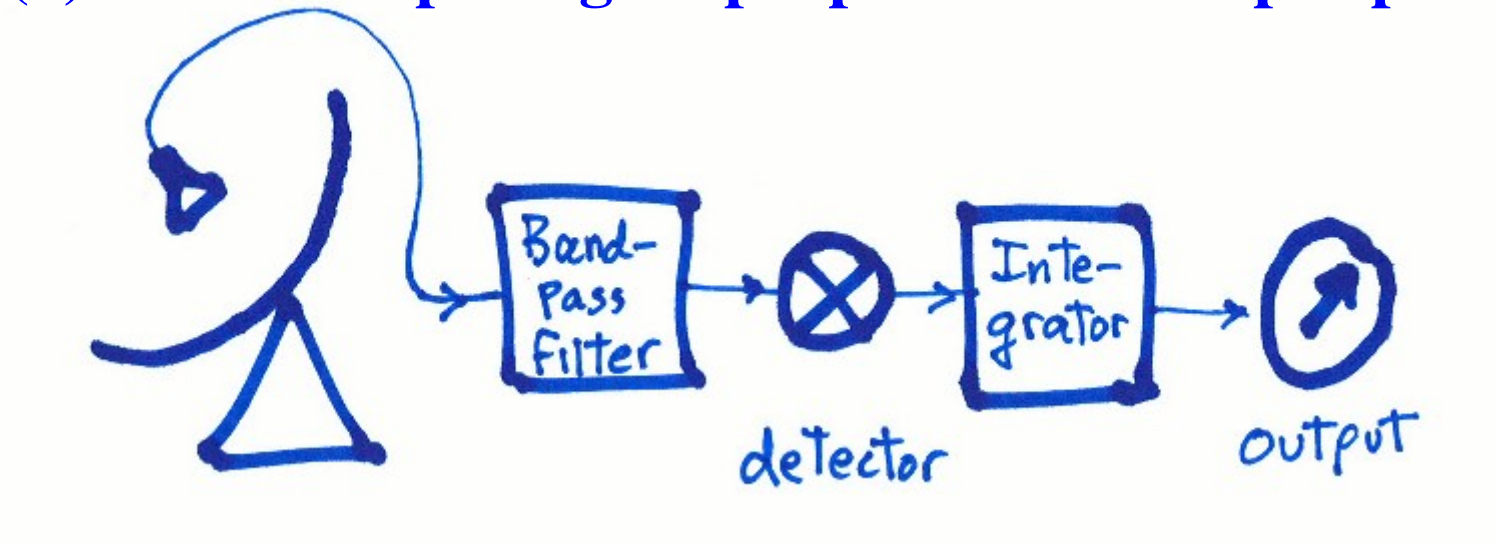

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Sensitivity of an ideal radiometer

If system temperature is *T*sys

... bandwidth is Δν

... integration time is Δt

then the sensitivity (1 sigma noise) will be

$$\Delta T = T_{sys} / \mathrm{sqrt}(\Delta\nu\, \Delta t)$$

i.e., goes down as sqrt(number of samples)!

Quiz