NEXT EXAM. Tuesday, March 18
Will cover material through today’s lecture
Stars – from formation and HR Diagram through Pulsars

Today’s Guest Lecturer: Randy McEntaffer

Website
http://casa.colorado.edu/~wcash/APS1120/APS1120.html
Pulsars

- Neutrons Stars considered unobservable
- Forgot the effect of magnetic fields
- When a magnetic spins it creates electric fields
- Electric fields create accelerated electrons
- Accelerated electrons create strong radio signals
- Pulsar is a spinning, magnetized neutron star
Intense Magnetic Field

Field not necessarily aligned with spin axis
Particles get thrown out along the polar axes (cannot cross field lines)
Beam radio signal along magnetic axis too.
From Above

Every time beam sweeps by we see a pulse
Lighthouse Analogy

Some of the Cosmic Rays that reach Earth could have been created in Pulsars
Pulse Trains

Listen to the Pulsars:

- PSR B0329+54  1.4Hz
- Vela Pulsar    11Hz
- Crab Pulsar   30 Hz
- PSR B1937+21  642Hz
Center of the Crab Nebula

Chandra (X-rays) and HST (Visible)
Pulsar Power

- Energy Source is the Rotation
- As Pulsar emits, rotation slows
- As pulsar slows, it becomes less luminous
- Rapidly fade out

![Chart showing period and time with glitches or starquakes](chart.png)
The Binary Pulsar

Pulses get closer on approaching side of orbit (Doppler)

Can map out orbit

Two neutron stars spiralling toward each other. Will merge into black hole in about 200,000 years

Friction that causes the inward spiral caused by Gravity Waves

First confirmation of Einstein’s prediction
An X-ray Pulsar

Hercules X-1  Discovered in 1971

Pulses every 1.24 seconds in the x-ray
Eclipses every 1.7 days due to binary orbit
Turns off every 35 days due to accretion disk wobble

The Rosetta Stone of X-ray Astronomy

Proved the bright x-ray sources were mass transfer binaries with a neutron star.

There are about 100 of these “Classical X-ray Binaries” in the Milky Way
Every few hours the x-ray source will “burst” for 30 seconds

Explanation: Helium accumulates on surface of the neutron star in binary
Periodically it explosively burns
Nuclear release insufficient to blow it out into space
Collapses back and cools

*A Neutron Star Nova*