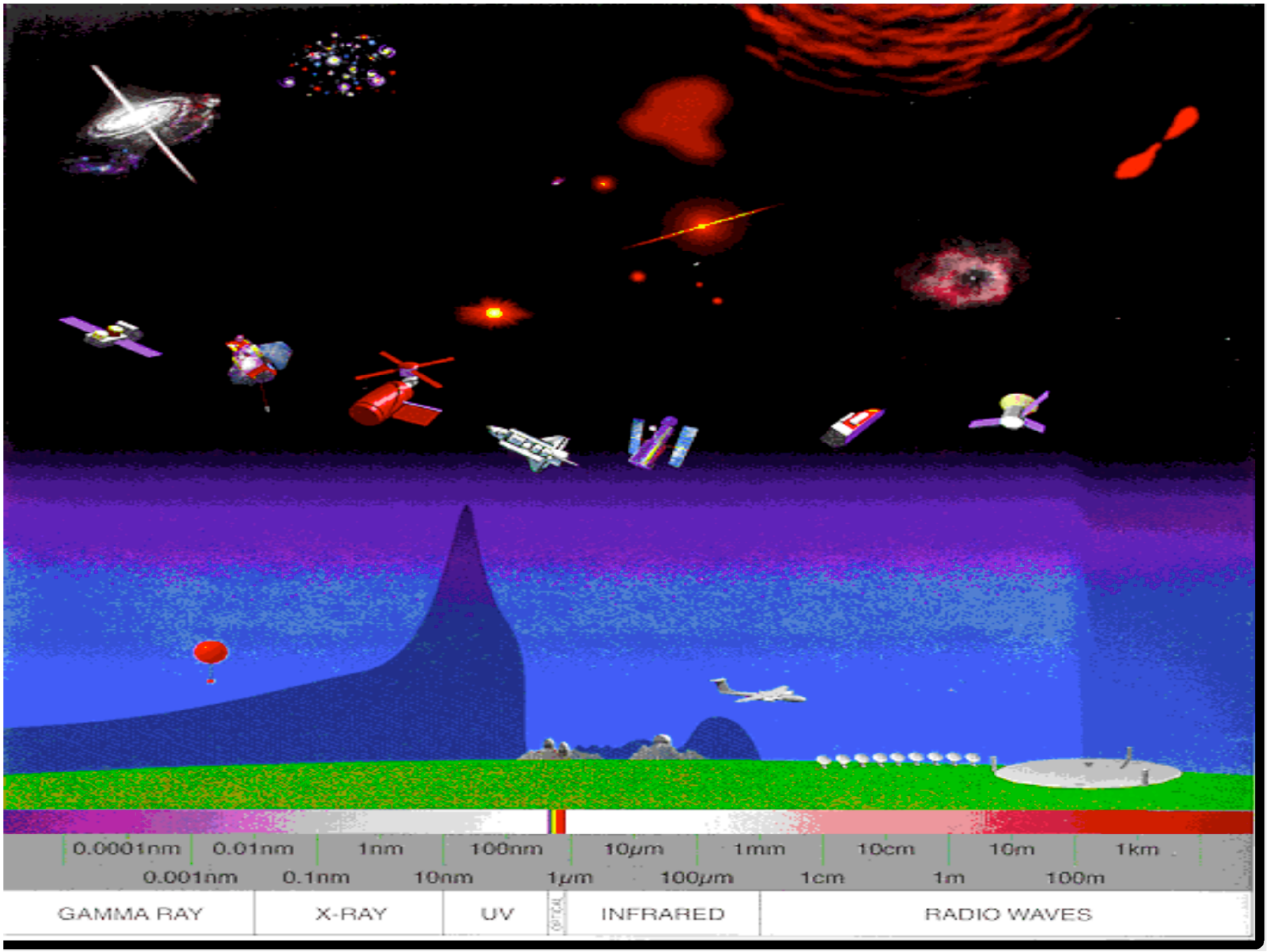
# Stellar Death

# Limits of Optical Observing

- dust absorbs optical light
  - will emit in infrared if heated
- gas optically transparent
  - may emit in radio, X-rays, or gamma-rays
- much of unexplored radiation outside visible from non-thermal processes
  - highly ordered motions such as electrons moving in magnetic fields
  - gamma-rays can come from nuclear reactions
- non-optical things vary ALOT!
  - higher energies – higher temperatures
    - higher temperatures don't stay around

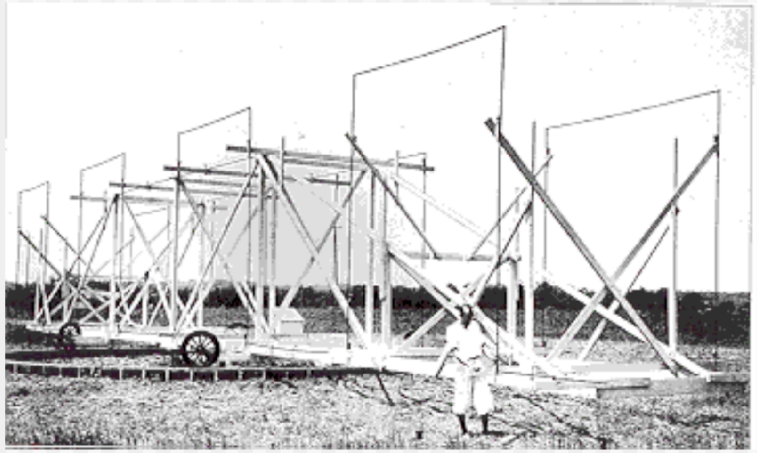
# New Detectors Needed

- ground-based radio telescopes
- most wavelengths blocked by atmosphere
  - chunk of infrared
  - all wavelengths shorter than visible light
  - must use satellites
- example:  gamma-rays cannot be focused
  - makes it difficult to tell where coming from
  - one very crude solution:
    - use rate comparisons between detectors of different orientations
- computer based methods of extracting images we can understand from data


0.0001nm
0.01nm
1nm
100nm
10μm
1mm
10cm
10m
1km
0.001nm
0.1nm
10nm
1μm
100μm
1cm
1m
100m
GAMMA RAY
X-RAY
UV
OPTICAL
INFRARED
RADIO WAVES

# Early Radio Astronomy

- Milky Way center
  - accidentally discovered in 1932 by Karl Jansky



- cosmic microwave background
  - accidentally discovered in 1964-1965
  - put 'Steady State' theory to rest

# Stellar Old Age

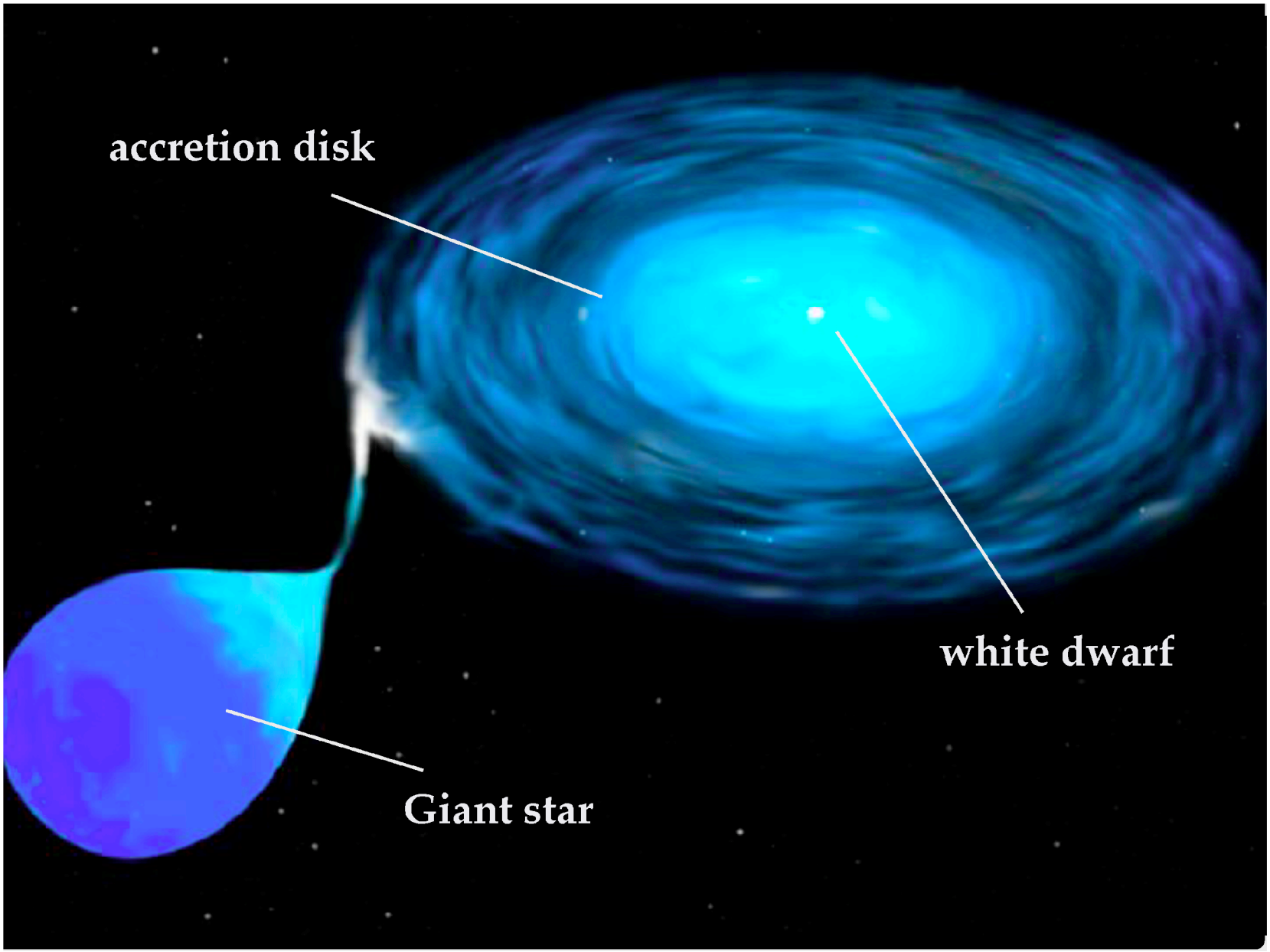
- initial fuel runs out in core
  - new fuels 'burned' (example: Helium)
  - star's structure changes
- giant, supergiant stages
  - pulsation - Mira variabless
    - fairly regular to semi-regular with long period (~1 year)
    - large amount of matter ejected from outer layers
- no more fuel left
  - collapsed object forms
    - becomes a white dwarf
  - ejection of large amount of matter into interstellar medium
    - planetary nebula formed
    - not well understood

# What is a White Dwarf?

- no energy source left
  - not hot enough to burn Carbon and Oxygen
- alot of star's mass left
- limitation to collapse
  - normally in matter
    - alot of space between atoms
  - electrons in atoms
    - don't like to be in same energy state as another
    - if 'overlap', called degenerate
    - a pressure is exerted by this
  - can support stars < 1.4 the Sun's mass
- very small - about size of Earth
  - size smaller with larger mass

# Cataclysmic Variables

- binary systems – white dwarf and a giant
- white dwarf  may pull matter from companion
  - might build up layer around it
    - gets hotter until thermonuclear reactions occur
  - might form accretion disk around white dwarf
    - orbits rapidly
    - hot spot where new material hitting disk
    - sudden changes in visocity cause runaway thermonuclear fusion
- blow off material accumulated
  - novae brighten by > 10 mag. in a few days
  - can start over again
    - dwarf novae every few months
    - recurrent novae every 10 to 1000 years


accretion disk
white dwarf
Giant star

# Type I Supernovae

- white dwarf in binary system
- may pull matter from companion
  - depending on how deposited
    - might not ignite to produce a nova
  - get more and more massive
- after about 100,000 of years
  - pass point where degeneracy can support star
  - fatal collapse in < 1 second
  - all degenerate matter explodes