"Perhaps the greatest anomaly in this situation is the incredibly weak scientific case for the whole scenario of cosmic evolution. There can be no "experiments" or "observations" of stars evolving, in the very nature of the case, so it cannot be scientific, though it may be naturalistic - all based on mathematical manipulations, computer simulations, and atheistic or pantheistic philosophies."

-Henry Morris in Creation by Inflation and Quantum Fluctuation

"I believe that a scientist looking at nonscientific problems is just as dumb as the next guy."

-Richard Feynman, 1968

"I believe that a theologian looking at nontheological problems is the next guy."

-Professor Scheidly, Just Now

Proxima Centauri:
Stellar parallax = 0.76"
Distance = 1/0.76 = 1.3 pc
Distance = 270,000 AU
Distance = 4.3 ly
Proper Motions of Stars...

\[ \frac{\Delta \lambda}{\lambda} = \frac{d}{t} = \frac{v_r}{c} \]

\[ \Delta \lambda = \frac{d}{t} = \frac{v_r}{c} \]

\[ V = \sqrt{v_i^2 + v_r^2} \]

\[ \theta = \tan^{-1} \frac{v_i}{v_r} \]

Apparent Brightness \propto \frac{Luminous Intensity}{Distance^2}

A change in apparent magnitude by 5 corresponds to an increase in apparent brightness by a factor of 100.

The log scale allows us to express large differences in a compact way.

<table>
<thead>
<tr>
<th>Spectral Class</th>
<th>Intrinsic Color</th>
<th>Surface Temperature (K)</th>
<th>Prominent Absorption Lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>Blue</td>
<td>41,000</td>
<td>He&quot;, O&quot;, N&quot;, Si&quot;, He, H</td>
</tr>
<tr>
<td>B</td>
<td>Blue</td>
<td>31,000</td>
<td>He, H, O&quot;, C&quot;, N&quot;, Si&quot;</td>
</tr>
<tr>
<td>A</td>
<td>Blue-white</td>
<td>9,500</td>
<td>H\textsuperscript{+}, Ca\textsuperscript{+}, Mg\textsuperscript{+}, Fe\textsuperscript{+}</td>
</tr>
<tr>
<td>F</td>
<td>White</td>
<td>7,240</td>
<td>H\textsuperscript{+}, Ca\textsuperscript{+}, ionized metals</td>
</tr>
<tr>
<td>G</td>
<td>Yellow-white</td>
<td>5,920</td>
<td>H\textsuperscript{+}, Ca\textsuperscript{+}, ionized &amp; neutral metals</td>
</tr>
<tr>
<td>K</td>
<td>Orange</td>
<td>5,500</td>
<td>Ca\textsuperscript{+}(strongest), neutral metals strong, H/He weak</td>
</tr>
<tr>
<td>M</td>
<td>Red</td>
<td>3,950</td>
<td>Strong neutral lines, TiO</td>
</tr>
</tbody>
</table>

\[ F = \sigma T^4 \]

\[ A = 4\pi R^2 \]

\[ L = 4\pi \sigma R^2 T^4 \]
General Solar Properties

Neutron Star: Eta Carinae

Neutron stars are the remnant of Type II (rebound) Supernova events.

- Roughly the size of a major city.
- 300,000 times more massive than the earth.
- Composed primarily of neutrons.
- Escape velocity is c/2
- Strong emission of radio waves.

Jocelyn Bell: 24 year old Cambridge grad student.
Detection of periodic radio signals in the constellation Cygnus.
Mysteriously regular at 1.33701 second intervals.

In 1974, her advisor, Anthony Hewish, was awarded the Nobel Prize in Physics for the discovery of the PULSAR!
Hubble Image of the Crab Nebula Pulsar
Rotates once every 0.0016 s!!!

Black Holes

Space-Time is Curved

Albert Einstein
General Theory of Relativity

- All massive objects distort space and time in their vicinity.
  - The distortion is the cause of
    - Gravity
    - Time Effects
    - Gravitational Red Shifting
    - Gravitational Lensing
Black hole properties:
• Light cannot escape
• Event horizon
• Mass (5 times the mass of the sun and greater)
• Angular momentum
• Charge (most are neutral)

How can we detect them if they are black?

Gravitational Lensing
Accretion Disk Emissions

Cygnus X-1
Deneb
Vega
Altair
End
IMPORTANT

- Relative Motion
- Apparent Magnitude
- HR Diagram
- Stellar Evolution
- The Principle of Equivalence
- Black Hole Properties

NEXT TIME: GALACTIC STRUCTURE