Starspots on LO Pegasi 2006-2013
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General Information about Starspots
- Starspots are cooler, darker regions of the stellar surface.
- Found in areas of strong perpendicular magnetic fields.

Flux Freezing
- Faraday’s Law of Induction and Ohm’s Law
  \[ \frac{\partial \phi_B}{\partial t} \quad I = \frac{\varepsilon}{R} \]
- As \( R \to 0, \varepsilon \to 0 \) in order that \( I \) not be infinite, requiring constant \( \phi_B \).
- Magnetic field lines are constrained to follow the plasma as it moves, which is known as **flux freezing**.

Starspot Formation
- Magnetic field lines are bundled in flux tubes, which are dragged with the plasma.
- The flux tubes are buoyant, so sometimes they rise and protrude from the surface of the Sun.
- Where the field lines intersect the surface, they are perpendicular to it.
- Because of \( \mathbf{qv} \times \mathbf{B} \) forces, the field lines act like elastic bands under tension, a phenomenon known as **magnetic tension**.
  - Magnetic tension resists horizontal motion of the plasma, suppressing convection within the spot.

Solar Cycle
- On the Sun’s surface, plasma at different latitudes rotates at different angular velocities, known as **differential rotation**.
- Differential rotation wraps the flux tubes around the Sun, an important component of the solar magnetic dynamo.

Babcock Solar Cycle Model

Instrumentation
- 0.3-m Meade LX200 Schmidt-Cassegrain telescope
- SBIG ST-8XE CCD Camera
- Standard astronomical B, V, R and I photometric filters

Errors Affecting Raw Images
- Dark Current Noise: Electrons excited thermally instead of via the photoelectric effect.
- Vignetting: Uneven illumination of the CCD by the telescope optics.

Image Calibration
- Dark frames: Exposures with the shutter closed, revealing thermal noise, are subtracted from the raw images.
- Flat fields: Images of a uniformly illuminated field by which the dark-subtracted images are divided to compensate for vignetting and unevenly responsive pixels.

Photometry
- Mira Pro 7 UE is used to do differential photometry on LO Pegasi.
- The brightness of LO Pegasi in each image is measured with reference to the comparison star, SAO 89758, and the check star, GSC 2188:1044.
- We use a comparison star to ensure that brightness fluctuations are intrinsic to LO Pegasi and not due to atmospheric effects.
- The check star is used to verify the constant brightness of the comparison star.

Results
- LO Pegasi rotates once every 10.153 hours.
- The rotational phase is the fractional part of the number of revolutions through which the star has turned since an arbitrary starting time.
- The light curve is stable over many revolutions, indicating that the spot configuration changes slowly.
- In 2012, the average brightness and amplitude was smaller than in previous years. This suggests the presence of a large spot centered on the visible rotation pole.
- In 2013, the star appears to have brightened and the modulation has increased, suggesting that the polar spot has shrunk in size and may have a protrusion towards lower latitudes.
- The plots of B-V and B-I show that the star is redder when it is dimmer, as expected since spots are cooler and thus redder than the rest of the stellar surface.

Background image: http://i388.photobucket.com/albums/oo328/becky_is_a_star_94/night-sky.jpg