**Topics for Today**

- **Solar magnetic dynamo:** how the Sun builds (and destroys) its magnetic fields
- **Start reading:** Chap 16, *Properties of Stars*
- **Next class:** What can we measure in other stars, how we classify them (O,B,A, etc.)

- **Observatory Night #3** today Mon 7 Feb (7pm, 8pm, 9pm -- by sign-up)
- **Review Sheet** still available for in-class Midterm Exam 1 this Fri 11 Feb (review session this Wed 11 Feb, 7pm, here)

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**Reading Clicker Q**

**B.**

- Helioseismology uses sound waves bouncing within the Sun to study flows and structures deep inside. How are they detected and measured?
  - A. By listening very carefully, since 5-minute periods hard to hear otherwise
  - B. By observing Doppler shifts of spectral line emitted by solar surface moving up and down
  - C. By seeing how solar prominences wiggle
  - D. By using the Zeeman effect
  - E. By its effect on 11-year solar activity cycle

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**Clicker – Doppler shifts?**

**A.**

- Star moving away from us at 0.01 the speed of light emits a spectral line with a wavelength of 600 nanometers (nm). What is the observed wavelength of that line?
  - A. 606 nm
  - B. 600.6 nm
  - C. 594 nm
  - D. 596.4 nm
  - E. 600 nm

\[ \Delta \lambda / \lambda = \frac{v}{c} \]

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**Sunspots show “Zeeman splitting”**

- 1000+ Gauss magnetic fields in sunspots
- B demo

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**Magnetic Solar Cycle 23**

- Cycle 23 Sunspot Number Prediction (July 2001)
11-year Cycles of Solar Activity

Butterfly Diagram

But what really is a “magnetic field”?

TRACE soft x-ray image: Arcade of magnetic loops on solar limb

Complex “magnetic carpet” in low corona

Flares involve huge releases of energy

"Magnetic reconnection": Fields change drastically, with intense electric currents

Many other stars flare -- with Sun you can see its details!

Major flare develops, loops light up

Another major flare (X-class)
What observed features characterize the Sun at “solar maximum”?

- A. Sun becomes much brighter
- B. Sun emits light of longer wavelengths
- C. Sun rotates faster at the equator
- D. Many sunspots are visible on surface
- E. All of the above
So how are solar magnetic fields built?

TWO MAGNETIC DYNAMOS:
Global magnetic fields built in TACHOCLINE
Small-scale fields built in near-surface shear zone

How differential rotation can stretch and change global magnetic fields

True, but only one element in story…

Computer Modelling of Solar Convection

Large-scale convection "drives the differential rotation"

Global View of Velocities in Simulations

Different Patterns Near Equator and Near Poles

Theoretical Solar Cycle