Index Card, Sep. 18

Examine the 2 images of the Sun, with Doppler shifts illustrated in red (motion away) and blue (towards).

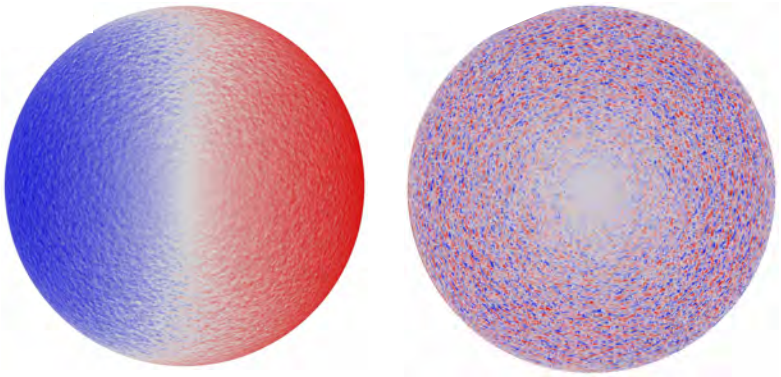
(a) Explain why the left-hand image looks blue on one edge and red on the other; what causes this?

75% of the groups got this right; the explanation had been given on a slide shown just before the activity.

(b) Explain what causes the speckles of red and blue in the right-hand image of "leftover" Doppler shifts.

Only 25% got this part right. It called for you to combine knowledge about the Sun with understanding of the Doppler shift.

Doppler Shifts on the Solar Surface

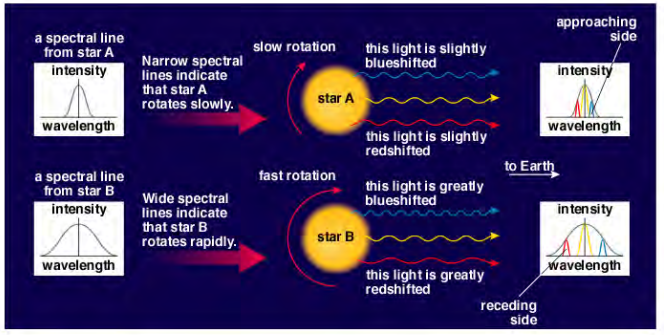


Left image: the Sun's *rotation* (spin)

- The Sun is spinning, or rotating on its axis. The blue-shifted side/edge is moving/turning towards us, while the red side is turning away from us. The white "stripe" in the middle is where our line of sight is perpendicular to the velocity (the turning motion is across our sight line), so there is no Doppler shift.
- "It looks blue on one edge and red on the other because the Sun is rotating; the blue side is rotating towards us while the red side is rotating away."

Rotational Velocities

If the object is big enough (in angle) that you can observe the two edges separately, you will see a Doppler shift from one edge to the other ….



Confusions about Doppler shifts

- "It's blue on the left because the light is going towards us, and red as it goes away." If we **see** light, it must be coming towards us! There is a Doppler shift only when *the source of the light* is moving towards us. Don't confuse motion of an object with motion (travel) of light.
- "We see a blue shift when an object is closer to us." The Doppler shift is *not* related to distance, it's a result of instantaneous ***velocity***. Blue shifts are *not* caused by an object being closer.
- "The blue side of the planet …" Three groups said this! This is **the Sun**, *not* a planet.

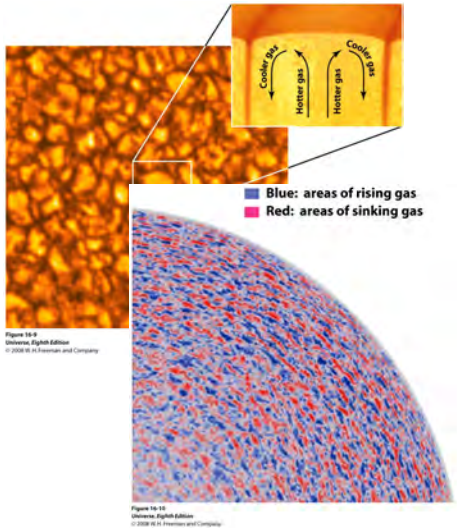
Right image: speckles show *convection*

- Once the rotational component (overall blue-to-red trend) is removed, the remaining red and blue spots or speckles represent the convection currents moving in and out of the Sun.
- "The leftover spots are due to the rise and fall of gas in the convection cells. The blue spots are gas moving [outward] towards us, and the red spots are gas moving away from us [falling back in]."
- Some groups did not discuss the "speckles," but just talked about how a white color indicated neither overall motion towards or away.

Evidence of Convection: Solar Surface

Convection brings energy to the surface in the form of hot gas

The bright blobs ("granules") on the photosphere are the tops of bubbles of hot gas (convection cells) breaking through the surface



Confusions and Misunderstandings

- "The red and blue spots are the photons moving forward and back on the star." Again, don't confuse photons and matter. We only see the photons coming towards us; we don't see photons that are going away from us!
- ".. the speckles are due to the photons taking the long walk." I presume you mean the random walk. No, this doesn't cause the patterns we see. The direction the photon travels doesn't cause a shift.
- ".. shifts catching up with each other." ??
- ".. from the Earth's orbit and rotation ..." Nope.
- ".. gas clouds absorbing the light." Again, nope.