Index Card, 11/06

When an aging, evolving star (e.g. becomes a red giant and beyond) happens to have a close companion star, which of the following properties of the first star can be affected or changed by the second star?

What kinds of changes can occur, and why?

- mass
- rotation
- how long it can last as a red giant
- any other quantity you can think of; explain

Changes in Mass

- Key Point: **Which** star gains mass from the other?
- "As the [first] star becomes a red giant, the outskirts of the star may be more strongly ~~affected~~ [attracted] by the gravity of the companion, causing mass loss."
- "It will take mass away from the companion star… the red giant receives mass from the smaller star." Why? If the separation of the two stars remain the same (at first), and the second star hasn't expanded, its mass should stay bound to itself.
- The mass of the non-red giant will be absorbed." Only in the extreme case of a "common envelope.

Changes in Rotation

- Key Point: Does it **slow down** or **speed up**?
- "The second star's rotation becomes more rapid, as the matter from the red giant makes it spin faster."
- … many of you drew a [correct] analogy to milli-second pulsars: "pulsars which have mass transferred onto them increase in rotational speed." It's like the hand on the bicycle wheel (in the video), applying a sideways push and thus speeding up the rotation rate.
- "the companion star slows the other's angular momentum …" Why? And angular momentum is a quantity that can be larger or smaller, not "slower"

Changes in Rotation

- "the rotation would change based on the gravitational pull by the other star." Gravity is not the dominant influence here; what changes rotation is basically the *transfer of angular momentum* along with the mass that is being donated by the red giant to the other star.
- "As the red giant loses mass, it will spin faster…" This is not the same situation as the contracting protostar or the massive-star core collapsing into a neutron star. In the binary situation, the angular momentum is not being conserved for each individual star, because the mass that is lost from the red giant star actually carries away momentum.

Changes in Red Giant Lifetime

- Key Point: Does it get **longer** or **shorter**? Opinions were fairly equally divided on this issue.
- "It will last as a red giant for a shorter time, because of the mass loss." Probably. The details will depend on the distance between the stars, but most likely the red giant phase will be truncated (cut short).
- "A red giant losing mass will last longer." Don't confuse this effect with the mass dependence of Main Sequence lifetimes; the red giant phase is a different phenomenon.
- "It will last longer … it takes longer for each step." ??
- "The period as a red giant would remain the same."

Misunderstandings & Confusions

- "As the red giant expands, it will begin breaking down the small companion star." Why? Maybe if it actually enveloped the other star, in which case you would have a "common envelope" situation.
- "Mass can't change, because it's an intrinsic property." Intrinsic doesn't mean *permanent*, it just means a property of the star alone.
- "Rotation changes because of the gravity of the other planet." These are stars, not planets, and gravity alone does not change rotation (unless you're talking about tidal effects, but this wasn't mentioned).

Other Properties?

- "Shape?" Yes, good idea! From the diagrams and videos you might notice that the stars can become almost teardrop-shaped as they fill a Roche lobe. Such distortions also can affect the brightness, because the star has a different cross-section (projected size) as seen from different angles.
- "Temperature?" Under some circumstances, the side of one star facing the other star will experience extra heating and might be hotter. This situation can develop when, for example, the second star is a white dwarf or some other hot type of star.