Computer simulations reveal formation mechanisms of wide binary stars

December 5 2012, by Louise Good

(Phys.org)—Our Sun is a single star. This puts it in a minority of stars because most stars are binaries—two stars that orbit each other and are bound together by their mutual gravity.

Binaries can be very close, sometimes so close that they actually touch each other. Other pairs are extremely wide, with separations up to a light-year or so.

Astronomers have known about such wide pairs for a long time, but how they form has been a mystery. The problem is that the typical cloud cores out of which stars are born are not large enough to form the widest binaries.

Now Dr. Bo Reipurth of the Institute for Astronomy, University of Hawaii at Manoa, USA, and Dr. Seppo Mikkola of Tuorla Observatory, University of Turku, Finland, have used computer simulations to come up with a mechanism that accounts for the formation of wide binaries.

Most stars are initially formed in small compact multiple systems with two, three or even more stars at the center of a cloud core. When more than two stars are together in a small space, they gravitationally pull on each other in a chaotic dance, where the lightest body is often kicked out to the outskirts of the core for long periods of time before falling back into the fray.

Meanwhile, the remaining stars feed on the gas at the center of the cloud

core and grow heftier. Eventually, the runt of the litter gets such a large kick that it may be completely ejected. But in some cases, the kick is not strong enough for the third body to fully escape, and so it is sent out into a very wide orbit.

The implication is that the widest binaries really should be three stars, not just two stars. Indeed, when astronomers carefully inspect the stars in a very wide system, they often find that one of them is a tight binary. But sometimes it appears that there really are only two stars in a wide system. This means that either wide binaries with only two stars are formed in another way, or something has happened to one of the stars that was once a close binary.

What may have happened is that the stars in the close binary merged into a single larger star. This can happen if there is enough gas in the cloud core to provide resistance to their motion. As the two stars in the close binary move around each other surrounded by gas, they lose energy and spiral toward each other. Sometimes there is so much gas in the core that the two close stars spiral all the way in and collide with each other in a spectacular merging explosion.

The nearest wide binary to us is Alpha Centauri, which is so similar to the Sun that it is almost a twin. Alpha Centauri is actually a close binary, but it also has a small distant companion called Proxima Centauri that is currently about 15,000 times the Earth-Sun distance, or about a quarter of a light-year, away. Several billions of years ago all three stars were born close together, before a violent event sent Proxima out into its wide orbit, where it has been moving ever since.

The paper by Reipurth and Mikkola about the formation of the widest binaries is published in this week's issue of the journal *Nature*.

More information: Formation of the widest binary stars from

dynamical unfolding of triple systems, *Nature* (2012)
doi:10.1038/nature11662