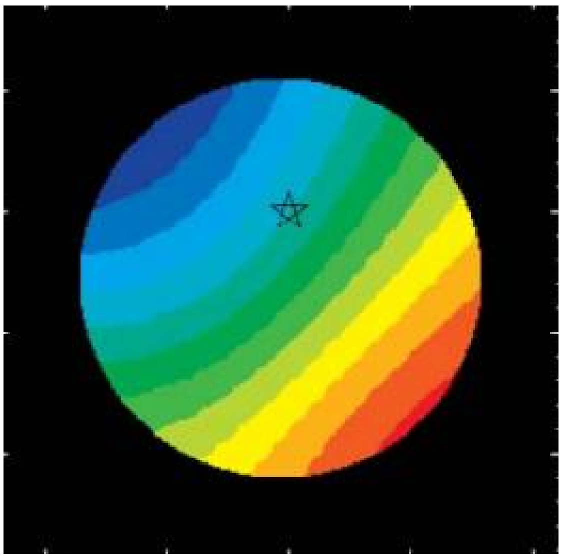
Simulating the Birth of Massive Stars

March 9 2010



New computer simulations of the flow of ionized gas around a massive young star appear to explain successfully some of the classical puzzles associated with massive star formation. The colors are coded to represent the velocity of an ionized wind, with red for gas moving away from the viewer and blue for gas moving towards the viewer. The star itself is located at the mark. Credit: ApJ, and Peters et al., 2010

(PhysOrg.com) -- Astronomers have made great strides recently in understanding how modest stars - those like the sun or smaller -- are formed.

It has been much harder, however, to sort out the processes involved in the birth of massive stars, those with more than about eight solar masses of material. These stars are critically important in the cosmic ecosystem because, among other things, they end up as supernovae which enrich the cosmos with elements essential to life.

The particular difficulties understanding massive star formation arise in part because massive stars mature much more quickly than do low mass stars, tend to form in groups, and are accompanied by a wider range of more vigorous activities including hot gas in ionized regions, accretion of material, and strong winds. Stars form from giant clouds of gas and dust in space as the matter in these clouds comes together.

Some theoretical models assert that massive stars form when smaller stars coalesce early in their lives. Other models indicate that individual large stars fragment out of huge clumps of collapsing matter, and that the distribution of stellar sizes is determined very early in this fragmentation process. Sorting out which scenario actually occurs in nature, if either, is one of the goals of modern astronomy research.

SAO astronomers Roberto Galvan-Madrid and Eric Keto, together with three colleagues, have just published the first computer simulations of the formation of massive stars that allow for structures to develop in full three-dimensions (rather than with imposed spatial symmetries), and that include effects of the ionizing radiation produced by massive stars. Their conclusions are significant. Many conventional models had predicted that stars would stop growing (that is, stop accreting new material) because of outward pressure from the ionizing radiation.

The team found that the ionizing radiation does not stop accretion. Instead, what happens is that the dense environment prompts the formation of multiple new stars, and these other stars halt the accretion onto the main star by capturing the material themselves. The authors call this process "fragmentation-induced starvation," and it, together with other results of their simulations, appears to offer realistic answers to many of the outstanding puzzles of massive star formation in clusters.

Provided by Harvard-Smithsonian Center for Astrophysics