Astronomers simulate life and death in the universe

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Stars always evolve in the universe in large groups, known as clusters. Astronomers distinguish these formations by their age and size. The question of how star clusters are created from interstellar gas clouds and why they then develop in different ways has now been answered by researchers at the Argelander Institute for Astronomy at the University of Bonn with the aid of computer simulations.

The scientists have solved – at least at a theoretical level – one of the oldest astronomical puzzles, namely the question of whether star clusters differ in their internal structure. The findings have now been published in the science journal *Monthly Notices of the Royal Astronomical Society* (MNRAS 380, 1589).

Astronomical observations have shown that all stars are formed in star clusters. Astronomers distinguish between, on the one hand, small and, by astronomical standards, young star clusters ranging in number from several hundred to several thousand stars and, on the other, large high-density globular star clusters consisting of as many as ten million tightly packed stars which are as old as the universe. No one knows how many star clusters there might be of each type, because scientists have not previously managed to fully compute the physical processes behind their genesis.

Stars and star clusters are formed as interstellar gas clouds collapse. Within these increasingly dense clouds, individual "lumps" emerge which, under their own gravitational pull, draw ever closer together and

finally become stars. Similar to our "solar wind", the stars send out strong streams of charged particles. These "winds" literally sweep out the remaining gas from the cloud. What remains is a cluster that gradually disintegrates until its component stars can move freely in the interstellar space of the Milky Way.

Scientists believe that our own sun arose within a small star cluster which disintegrated in the course of its development. "Otherwise our planetary system would probably have been destroyed by a star moving close by," says Professor Dr. Pavel Kroupa of the Argelander Institute for Astronomy at Bonn University. In order to achieve a better understanding of the birth and death of stellar aggregations Professor Kroupa and Dr. Holger Baumgardt have developed a computer programme that simulates the influence of the gases remaining in a cluster on the paths taken by stars.

Heavy star clusters live longer

The main focus of this research has been on the question of what the initial conditions must look like if a new-born star cluster is to survive for a long time. The Bonn astronomers discovered that clusters below a certain size are very easily destroyed by the radiation of their component stars. Heavy star clusters, on the other hand, enjoy significantly better "survival chances".

For astronomers, another important insight from this work is that both light and heavy star clusters do have the same origins. As Professor Kroupa explains, "It seems that when the universe was born there were not only globular clusters but also countless mini star clusters. A challenge now for astrophysics is to find their remains." The computations in Bonn have paved the way for this search by providing some valuable theoretical pointers.

The Argelander Institute has recently been equipped with five "GRAPE Computers", which operate at speeds 1,000 times higher than normal PCs. They are being deployed not only in research but also for research-related teaching: "Thanks to the GRAPE facilities, our students and junior academics are learning to exploit the power of supercomputers and the software developed specially for them." The Argelander Institute is regarded world-wide as a Mecca for the computation of stellar processes. Despite their enormous calculating capacity, the machines require several weeks to complete the simulation.

Source: University of Bonn