

Which stars explode as supernovae?

In around 5 billion years our Sun will finish its life by becoming a red supergiant — expanding so much that it will engulf some planets, even the Earth — and eventually will eject the outer layers and become a white dwarf. However, the evolution of more massive stars is completely different. Those ten times more massive than the Sun after a short life of a few tens of million years explode as supernovae — one of the most energetic events in the Universe. The understanding of supernovae is very important from three points of view. First, they represent the endpoints of massive stars, so in order to have a full picture of stellar evolution, we need to know the details of these explosions. Second supernovae release many heavy elements from which the next generation of stars and also planets can form. Finally, they also heat the gas around them, which explains why some galaxies stop forming stars.

Observationally, supernovae are divided into several classes depending on which emission lines are visible in their spectra: type II (with hydrogen lines), type Ib (without hydrogen lines) and Ic (without hydrogen or helium lines). Very little is known about which stars explode as which type of supernovae. This is what I want to address in this project. If supernovae type Ib/c are explosions of extremely massive stars (30 times more massive than the Sun), then it takes very little time (around one million years) from the birth of the star to the explosion, so these supernovae should be found in dense molecular clouds. If these supernovae are binary systems of less massive stars, then their evolution takes longer, so at the time of explosion, there should be less molecular gas there.

With the largest radio telescope in the world Atacama Large Millimeter Array (ALMA) in Chile, it is for the first time possible to make this distinction. I am leading a large program with ALMA within which I am observing the environment of different supernova types. This will allow me to discover what stars explode as what type of supernovae.