Academia Sinica Press Release

Astronomers Find New Type of Explosive Outflow in the Orion Nebula

It is now well known that in the later stages of star formation, some of the circumstellar material will be expelled carrying away excess angular momentum. This allows the material which has less angular momentum to continue to fall towards the central star. This phenomenon of outflowing material is known as ‘molecular outflow’ because the material that is expelled is mostly composed of hydrogen molecules. The outflow usually occurs in a bipolar fashion, exiting above and below a circumstellar disk of material that will become a star. However, in the center of the Orion Nebula, the closest region of massive star formation to earth, a very different and energetic outflow is observed. The outflow is viewed most spectacularly in the infrared as fingers of shocked gas. The origin and nature of this type of outflow, which seems to flow out in all directions, has been an enigma for thirty years.

Now, an international collaboration of astronomers, including Dr. Paul Ho, Director of the Institute of Astronomy and Astrophysics, have found that the molecular outflow in Orion can be resolved into a large set of jet-like structures which all point back to a common origin. Each of the some forty resolved emission filaments appears to move in a straight line, with the velocity along the filament scaling as the distance from the center. This is highly suggestive of an explosive event with a single pulse of acceleration, where each packet of ejected material then travels radially outward with the highest velocities moving the furthest distance over time. The findings of the group, which were made using the Submillimeter Array (SMA) radio interferometer on Mauna Kea in Hawaii, were published in the October 10 issue of *The Astrophysical Journal Letters*.

Dr. Luis Zapata of the Max Planck Institute for Radio Astronomy, who leads the project, states that “The ‘explosive’ center of the outflow turns out to coincide with the position from which three bright young stars have been measured, via their radio emission, to be also flying apart.” This is a strong hint that a close encounter between members of a stellar system may have triggered an explosive outflow with motions on the order of 100 kilometers per second. From the motions, it is deduced that the explosion occurred about 500 years ago.

Dr. Ho, who was the Ph.D. supervisor of Dr. Zapata, reports that “This beautiful result, making use of the high angular resolution of the interferometer, and the 1 mm line of the CO molecule, for the first time, show that this particular outflow is a completely different phenomenon from what is seen when a star is being formed.”

Dr. Frank Shu, an internationally known astronomer and Academia Sinica Academician said: “This new research finding is extraordinary and exciting. It provides yet another illustration of the power of the SMA, which has propelled Taiwan astronomers, together with their coworkers at the CfA and elsewhere, to the forefront of observational radio astronomy. These beautifully detailed maps of 'stringy' molecular outflows in the Orion KL region, pointing to a single explosive origin 500 years ago, will undoubtedly stimulate much theoretical thinking. The basic physics is still an enigma.”

The Submillimeter Array, located on Mauna Kea in Hawaii, is a radio interferometer operated jointly by the Smithsonian Astrophysical Observatory and the Academia Sinica Institute of Astronomy and Astrophysics. The Submillimeter Array is the fore-runner of the Atacama Large Millimeter/submillimeter Array currently under construction in Chile. Taiwan is a partner on this advanced instrument.

The full article entitled: “Explosive disintegration of a massive young stellar system in Orion” can be found in the October 10 Issue of The Astrophysical Journal Letters at: http://www.iop.org/EJ/abstract/1538-4357/704/1/L45/

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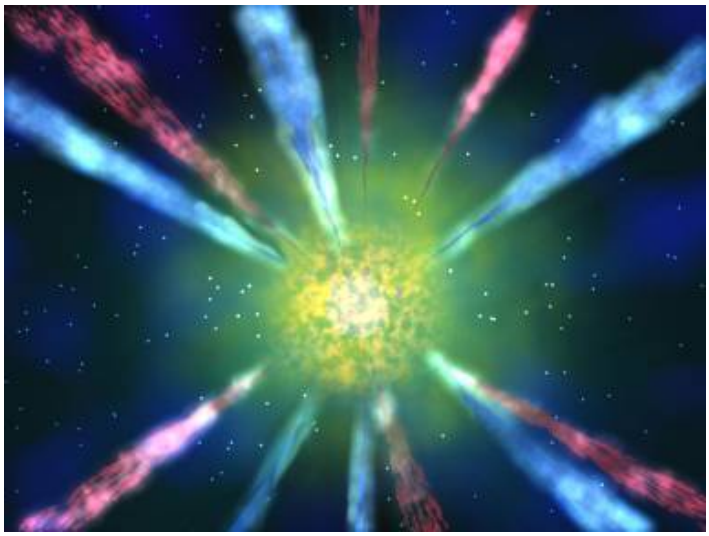

Caption: Artist's conception of this research result. In the central area there is a stellar system of three stars. The interaction between the members of the system may have triggered an explosive outflow. Some forty emission filaments exited from the center, flowing out in all directions. (Picture credit: Change Tsai/ASIAA)

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