Understanding stellar explosions is less straightforward than previously thought

April 30 2009

(PhysOrg.com) -- Stellar explosions called novæ are caused by nuclear reactions between the star's atoms. In order to better understand such violent phenomena, astrophysicists study the radiation emitted by certain types of atom, and in particular the fluorine-18 produced by these reactions.

Now, researchers at GANIL (The French large heavy-ion accelerator located in Caen), in collaboration with teams from the UK, Belgium, Romania and France, have determined that fluorine-18 appears to be less abundant than expected. This discovery therefore reduces the chances of observing the radiation emitted by this atom. It implies new constraints for the observation and understanding of novæ. This work has just been published in the journal Physical Review Letters.

Observed since ancient times, novæ are stellar explosions which occur in our galaxy around 20 times a year. Today, physicists think that they take place in stellar binary systems, which are made up of two stars, a red giant and a small, hot companion called a white dwarf. "Matter is torn off the red giant and falls onto the surface of the white dwarf," explains François de Oliveira Santos, a physicist working at GANIL. "This stellar matter accumulates on the surface of the white dwarf, leading to an increase in its temperature and density. A number of nuclear reactions, transforming one or more atomic nuclei into other particles, then take place: stable atomic nuclei (carbon, oxygen, etc) in the star are transformed into radioactive nuclei, such as fluorine-18." It is by observing the radiation emitted by these particles that researchers hope

to better understand the physical processes taking place during novæ.

Fluorine-18 is a radioactive atom whose unstable nucleus is deficient in neutrons compared to its stable form, fluorine-19. When it disintegrates, fluorine-18 emits specific electromagnetic radiation that astrophysicists study in order to get a better understanding of what goes on inside novæ. "The amount of radiation emitted during the explosion depends on the amount of fluorine-18 present," de Oliveira Santos explains. In order to show this, researchers have tried to identify all the nuclear reactions that lead to the creation and destruction of fluorine-18. Since these reactions depend on the structure of the nuclei, they have been studied with the use of particle accelerators.

An experiment carried out at Louvain-la-Neuve University in Belgium, as part of an international collaboration, has led scientists to revise downwards their estimate of the amount of fluorine-18 present in novae. The conclusion is that nuclear reactions involving fluorine-18 in these explosions lead to its destruction to a greater degree than had previously been estimated. "Our result is in agreement with recent theoretical work," de Oliveira Santos points out. "We obtained this result thanks to a new experimental technique that uses beams of accelerated radioactve nuclei." It leads to new constraints for the observation and understanding of stellar explosions.

More information: Discovery of a New Broad Resonance in 19Ne : Implications for the Destruction of the Cosmic -Ray Emitter 18F. J. C. Dalouzy, L. Achouri, M. Aliotta, C. Angulo, H. Benhabiles, C. Borcea, R. Borcea, P. Bourgault, A. Buta, A. Coc, A. Damman, T. Davinson, F. de Grancey, F. de Oliveira Santos, N. de Séréville, J. Kiener, M. G. Pellegriti, F. Negoita, A. M. Sánchez-Benítez, O. Sorlin, M. Stanoiu, I. Stefan, and P. J. Woods, *Physical Review Letters*. 24 April 2009

Provided by Laboratoire CNRS EN LUTTE- Physique et Mecanique des

Miliieux Heterogeneous (news : web)