

HOW NEUTRINOS AID IN THE DEATH OF MASSIVE STARS

Relevant for: Science & Technology | Topic: Science and Technology- developments and their applications and effects in everyday life

Weak but significant: Most of the energy of the supernova is carried away by neutrinos. | Photo Credit: [tose](#)

Many stars, towards the end of their lifetimes, form supernovas - massive explosions that send their outer layers shooting into the surrounding space. Most of the energy of the supernova is carried away by neutrinos – tiny particles with no charge and which interact weakly with matter. Researching the mechanisms of the so called Type II supernovas, a team from IIT Guwahati has come up with new insights into the part played by neutrinos in this dramatic death of massive stars. The collaboration includes astrophysicists from Max Planck Institute, Munich, Germany; Northwestern University, Illinois and University of California, Berkeley, in the U.S.

All stars burn nuclear fuel in their cores to produce energy. The heat generates internal pressure which pushes outwards and prevents the star from collapsing inward due to the action of gravity on its own mass. But when the star ages and runs out of fuel to burn, it starts to cool inside. This causes a lowering of its internal pressure and therefore the force of gravity wins; the star starts to collapse inwards. This builds up shock waves because it happens very suddenly, and the shock wave sends the outer material of the star flying. This is what is perceived as a supernova. This happens in very massive stars.

In stars that are more than eight times as massive as the Sun, the supernova is accompanied by a collapsing of the inner material of the dying star – this is also known as core collapse supernova or Type II supernova. The collapsing core may form a black hole or a neutron star, according as its mass. “Our work is on these core-collapse events of type II supernova,” says Sovan Chakraborty of the physics department of IIT Guwahati, in an email to *The Hindu*.

Neutrinos come in three ‘flavours’, another name for ‘types’, and each flavour is associated with a light elementary particle. For instance, the electron-neutrino is associated with the electron; the muon-neutrino with the muon and the tau-neutrino with the tau particle.

As they spew out of the raging supernova, the neutrinos can change from one flavour to another in a process known as neutrino oscillations. As Dr. Chakraborty explains, due to the high density and energy of the supernova, several interesting features emerge as this is a nonlinear phenomenon: “This [phenomenon] may generate neutrino oscillations happening simultaneously over different energies (unlike normal neutrino oscillation), termed collective neutrino oscillation. The oscillation result may dramatically change when one allows the evolution with the angular asymmetry, the oscillations can happen at a nanosecond time scale, termed fast oscillation.”

Models of this process, dubbed the effective two-flavour models, have only taken into account the asymmetry between electron neutrino and the corresponding antineutrino. In a paper published in *Physical Review Letters*, the researchers from IIT Guwahati claim that a three-flavour model is needed to predict well the dynamics of the supernova.

The fast oscillations are important because the researchers find that these can decide the flavour information of the supernova neutrinos.

So far, this has not been done, and models have only kept terms involving a neutrino and its corresponding anti-neutrino. “We find that fast nonlinear oscillations of neutrinos are sensitive to three flavours, and neglecting the third flavour may yield the wrong answer,” says Dr. Chakraborty. “Thus, the presence of ...[asymmetry between] the muon neutrinos and antineutrinos will be crucial for the neutrino oscillations, in turn influencing the supernova mechanism.”

Understanding this is important when one wants to measure the influence of neutrinos and their oscillations on supernova mechanism and heavy element synthesis in stellar environments.

This story is available exclusively to The Hindu subscribers only.

Already have an account ? [Sign in](#)

Start your 14 days free trial. [Sign Up](#)

Find mobile-friendly version of articles from the day's newspaper in one easy-to-read list.

Enjoy reading as many articles as you wish without any limitations.

A select list of articles that match your interests and tastes.

Move smoothly between articles as our pages load instantly.

A one-stop-shop for seeing the latest updates, and managing your preferences.

We brief you on the latest and most important developments, three times a day.

*Our Digital Subscription plans do not currently include the e-paper, crossword and print.

Dear reader,

We have been keeping you up-to-date with information on the developments in India and the world that have a bearing on our health and wellbeing, our lives and livelihoods, during these difficult times. To enable wide dissemination of news that is in public interest, we have increased the number of articles that can be read free, and extended free trial periods. However, we have a request for those who can afford to subscribe: please do. As we fight disinformation and misinformation, and keep apace with the happenings, we need to commit greater resources to news gathering operations. We promise to deliver quality journalism that stays away from vested interest and political propaganda.

Dear subscriber,

Thank you!

Your support for our journalism is invaluable. It's a support for truth and fairness in journalism. It has helped us keep apace with events and happenings.

The Hindu has always stood for journalism that is in the public interest. At this difficult time, it becomes even more important that we have access to information that has a bearing on our health and well-being, our lives, and livelihoods. As a subscriber, you are not only a beneficiary of our work but also its enabler.

We also reiterate here the promise that our team of reporters, copy editors, fact-checkers, designers, and photographers will deliver quality journalism that stays away from vested interest and political propaganda.

Suresh Nambath

Please enter a valid email address.

Indian antivenoms were ineffective in neutralising venoms of cryptic kraits

You can support quality journalism by turning off ad blocker or purchase a subscription for unlimited access to The Hindu.

[Sign up for a 30 day free trial.](#)

END

Downloaded from **crackIAS.com**

© **Zuccess App** by crackIAS.com

CrackIAS!