Kent astrophysicists solve the recycling mystery of life in the Universe

A fundamental missing link essential for life in the Universe to have evolve has been successfully simulated by theoretical astrophysicists at the University of Kent. “We were at first perplexed by the results coming out of the computer,” explained Professor Smith of the Centre for Astrophysics & Planetary Science, “and it was along journey, exploring the circumstances and conditions, to reach our conclusions”.

Scientists have long known that all that our bodies contain was not present when the Universe first turned on. We have also known that these elements such as carbon and oxygen must have formed deep inside stars. If a star explodes, that would release the ingredients for life. “The trouble is: almost all stars do not explode. A necessary step is then to extract these elements by some other means, and then to recycle them into the planets and biospheres” explained PhD student Igor Novikov. Easy? Well, yes, stars like our Sun eventually throw off their mantles as they get old, releasing shells of material which have been dredged up from their cores. The shells form magnificent manifestations called Planetary Nebulae.

The mystery concerns the next link in the chain: how do the shells crack, and this material manage to pollute our Galaxy? What causes the shells to mix with the interstellar medium? “We needed to understand what happens to the expelled shells from the dying red giants,” explained Professor Michael Smith. “The shell must be
temporary. If it stays intact, then our Universe would be unoccupied by us or anybody else for that matter.”

This is where PhD student Igor Novikov took over. He ran sophisticated simulations on Professor Smith’s aptly named ‘Forge Supercomputer.” There were so many options in terms of the speed and shape of the shells. The shells could consist of warm atoms and dust particles, or the atoms could be combined into molecules. It was hard work.”

Simulations of the embryos of Planetary Nebulae – Protoplanetary Nebulae – were performed. These revealed the answer. “Most shells are likely to be cold and molecular. These shells degenerate into protruding fingers and so lose their integrity,” explained Prof. Smith. In contrast, the warm atomic shells remain intact while large bubbles would occur if the shells were hotter. “It is now clear to us that the carbon can indeed be transferred efficiently through these fragmenting processes, and can go on to be recycled into new stars and planets.

However, Professor Smith points out that the Universe is not static. “It is a dynamic Universe in which our civilization happens to exist when the generation of recycled material is at its highest. That is probably no coincidence. There may well be other life in our Galaxy or one nearby, also enjoying these propitious conditions!”

The full results and conclusions have just been published in the Monthly Notices of the Royal Astronomical Society entitled "Numerical simulations of wind-driven protoplanetary nebulae. II. signatures of atomic emission"

Journal: Monthly Notices of the Royal Astronomical Society
DOI: 10.1093/mnras/stz2377
Title: Numerical simulations of wind-driven protoplanetary nebulae. II. signatures of atomic emission

Movies displaying observable predictions for protoplanetary nebula are available here: http://astro.kent.ac.uk/~in32/ppn.html

https://sci.esa.int/web/iso/-/12848-complex-organic-molecules-form-quickly-in-old-stars

How a shell disintegrates, zoomed in: