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Delivery of complex organic compounds from evolved stars to the solar system

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The last phase of stellar evolution from the asymptotic giant branch (AGB) to proto-planetary nebulae, to planetary nebulae represents the most active period of synthesis of organic compounds in a star's life. Both inorganic and organic molecules and solids are found to form in the circumstellar envelopes created by stellar winds. Over 60 gas-phase molecules, including rings, radicals, and molecular ions have been identified by millimeter-wave and infrared spectroscopic observations through their rotational and vibrational transitions.

Infrared spectroscopic observations of emissions from the stretching and bending modes of aliphatic and aromatic compounds have revealed a continuous synthesis of organic material from the end of the AGB to proto-planetary nebulae, to planetary nebulae. The results from the ISO and Spitzer space missions show that complex carbonaceous compounds can be produced in a circumstellar environment over a period of only a few thousand years. Most interestingly, there are a number of unidentified emission features which are almost certainly carbonaceous in nature but their exact chemical composition is unknown. These include the 21 and 30 micron emission features, and the extended red emission observed in proto-planetary nebulae and planetary nebulae.

Isotopic analysis of meteorites and interplanetary dust collected in the upper atmospheres have revealed the presence of pre-solar grains similar to those formed in evolved stars. This provides a direct link between star dust and the solar system and raises the possibility that the early solar system was chemically enriched by stellar ejecta with the potential of influencing the origin of life on Earth.