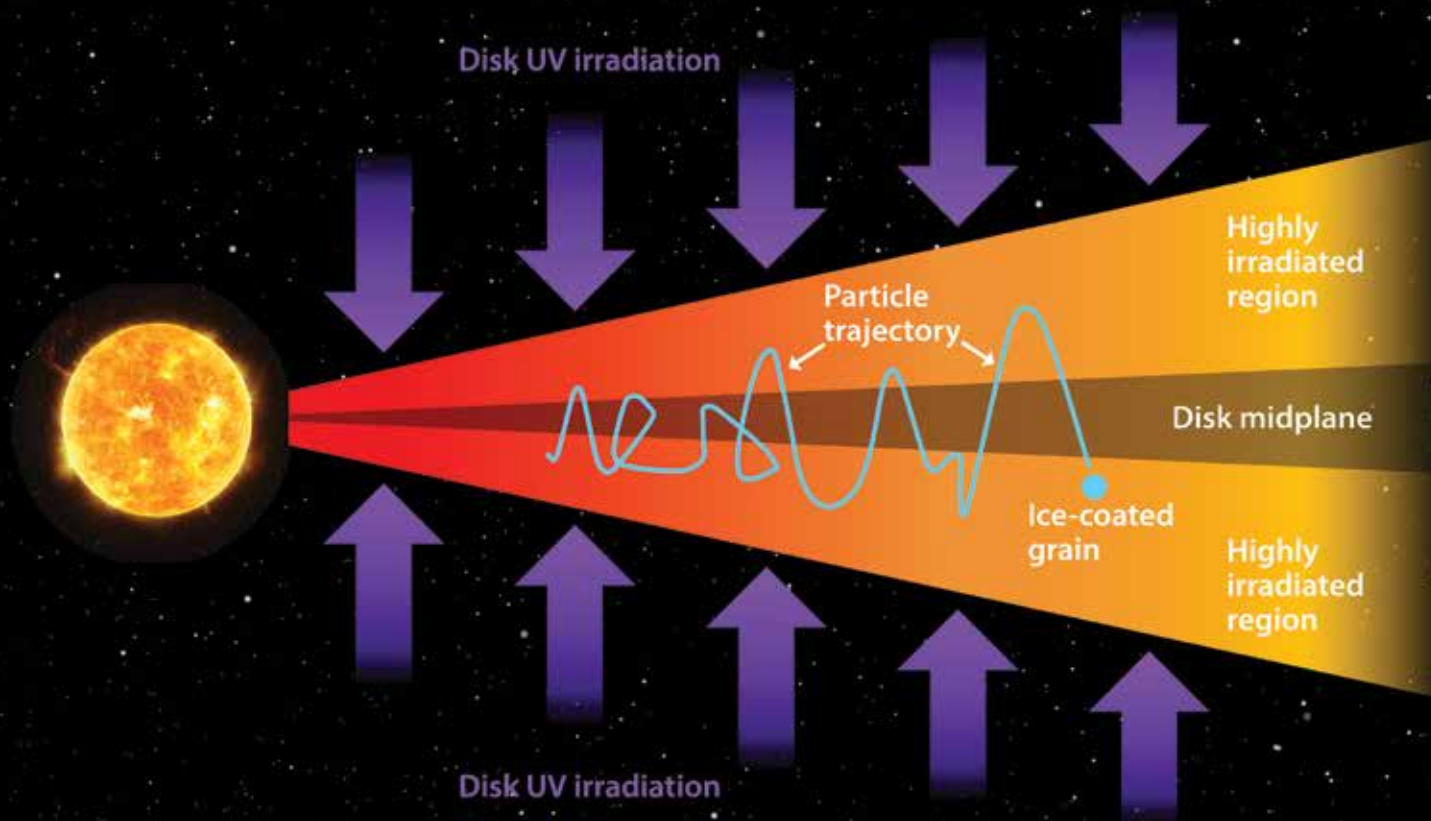




POTENTIAL FOR LIFE IN JUPITER SYSTEM

An international team that included SwRI demonstrated how complex organic molecules (COMs), key chemical precursors to life, could have been incorporated into Jupiter's Galilean moons during their formation. The team's findings resulted in complementary studies published in *The Planetary Science Journal* and *Monthly Notices of the Royal Astronomical Society*, offering new insights into the potential for life in the Jupiter, or Jovian, system.

Carbon-rich compounds containing oxygen, nitrogen and other elements are necessary for living matter to form. Laboratory experiments have shown that COMs can form when icy grains containing methanol or mixtures of carbon dioxide and ammonia are exposed to either ultraviolet radiation or moderate heating under conditions found in protoplanetary disks. These disks of gas and dust surround newly formed stars that eventually form planets.

"By combining disk evolution with particle transport models, we could precisely quantify the radiation and thermal conditions the icy grains experienced," said Dr. Olivier Mousis of SwRI's Solar System Science and Exploration Division, who is lead author of one of the two studies. "Then we directly compared our simulations with other laboratory experiments that produce COMs under realistic astrophysical conditions. The results showed that COM formation is possible in both the protosolar nebula environment and Jupiter's circumplanetary disk."

The research team developed advanced models detailing the evolution of the protosolar nebula, which formed the Sun and the planets, and Jupiter's circumplanetary disk, which formed the gas giant and its many moons. The team coupled their models with a grain-transport module that tracked the motion of icy particles through these two environments,

allowing them to reconstruct the physical and chemical histories of the moon-building materials. The team focused on the formation of Jupiter's Galilean moons: Europa, Ganymede, Callisto and Io, which are Jupiter's four largest and most-studied moons.

Their findings showed a significant proportion of icy grains could have acquired COMs and efficiently transported them to the region where Jupiter's moons accreted. The research pointed toward regions in Jupiter's circumplanetary disk with sufficient heat to trigger the organic chemistry essential for COM creation. Consequently, these findings support Jupiter's moons inheriting organic material from both the larger solar nebula and from processes occurring within their local formation environment billions of years ago.

Europa, Ganymede and Callisto are believed to contain subsurface oceans beneath their icy surfaces, which are promising conditions for the evolution of life. An early incorporation of COMs into these moons means that, in addition to having water and active energy sources, the Galilean moons likely also possess the chemical building blocks that could fuel prebiotic processes, such as the formation of amino acids and nucleotides.

"Our findings suggest that Jupiter's moons did not form as chemically pristine worlds," Mousis said. "Instead, they may have accreted, or accumulated, a significant inventory of COMs at birth, providing a chemical foundation that could later interact with the liquid water in their interiors."

NASA's Europa Clipper and the European Space Agency's Juice missions are currently traveling to the Jovian system to study the composition, structure and potential habitability of Jupiter's moons.