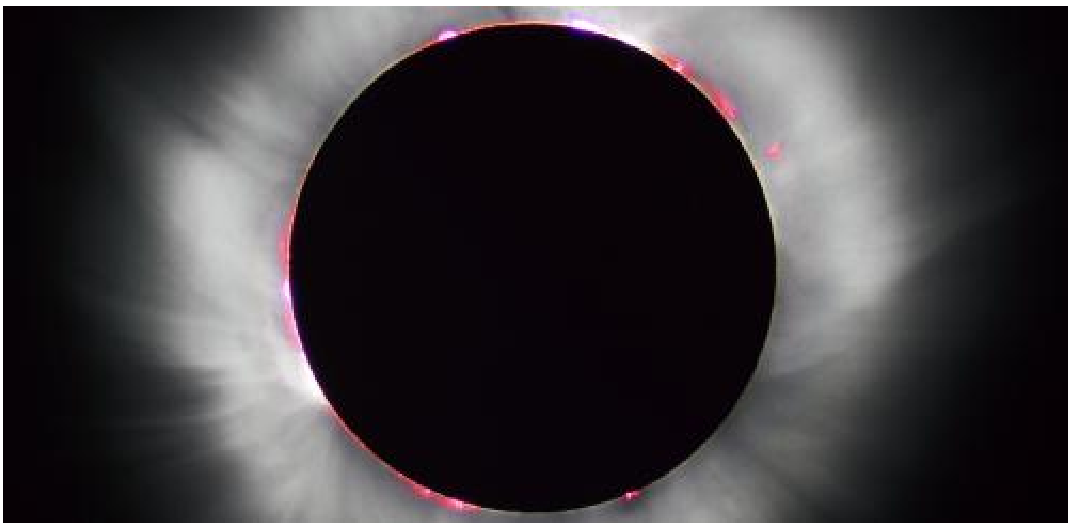
Solar wind and space dust create new source of water, laboratory study suggests

January 21 2014, by Akshat Rathi



New source of water? Credit: luc_viatour

Water ice is the most abundant solid material in the universe. Much of it was created as the byproduct of star formation, but not all. John Bradley of Lawrence Livermore National Laboratory and his team may have discovered a new source of water in our solar system. His lab experiments reveal that the solar wind may be creating water on interplanetary dust.

The sun ejects high-speed charged particles in all directions. Bodies in the inner solar system get bombarded by this wind of particles, which continuously varies in intensity.

Small bodies, such as dust particles or tiny asteroids, can be eroded by these harsh winds. Larger bodies that do not have an atmosphere, such as the Moon, are bombarded by both the solar wind and tiny meteorites. This form of bombardment causes a phenomenon called space weathering. (Atmospheres protect planets from tiny meteorites, while a magnetic field can deflect solar winds.)

The lunar dust brought back by the Apollo missions showed for the first time the result of space weathering – though not immediately. A careful examination of the dust returned from the lunar surface had to wait until the 1990s when scientific instruments became good enough. When finally observed under sufficiently powerful microscopes, the dust particles revealed what have been called "rims."

These dust particles are usually made of silicates – compounds of silicon, oxygen, hydrogen and few metallic elements. The rims are the result of chemical modification of the surface of the particle, caused by high energy impacts and the continuous bombardment of the solar wind.

The modification leads to an imbalance in the chemical structure of the particle, sometimes loosening the bonds holding oxygen and hydrogen atoms in the silicates. This made scientists speculate that there is a chance that water could be formed somewhere in these rims .

Water needs two atoms of hydrogen and one of oxygen. If silicates provide one atom of each element, then only one more hydrogen atom is needed. Conveniently, hydrogen atoms are available in abundance in the solar wind, where they are found as high-energy protons (hydrogen atoms stripped off their electrons). If the conditions are right, this charged hydrogen atom can react on a dust particle's rim to form water.

Plausible as this seems, past attempts to find water on these rims gave mixed results. The problem was that the reactions were happening at such tiny scales, and instruments weren't good enough to unambiguously detect water.

That's where Bradley's work comes in. The team attempted to locate water using a highly-sensitive method of analysis called valence electron energy-loss spectroscopy. The method involves exposing a sample to a beam of electrons that, on hitting the material, will get deflected at different speeds. The deflection and the speeds can reveal how much energy was lost by the electrons in the process, which is based on the type of atom it hits. The instrument can identify the composition of a material at very small scales, just enough for Bradley to analyse silicate rims.

The best way to determine whether water forms on silicate rims is to do these experiments on the types of silicate material that exist in space. Bradley did this by using three types of these minerals: olivine, clinopyroxene, and anorthine. These were exposed to charged hydrogen and helium particles, which were a proxy for the solar wind.

If water is formed by the solar wind, it would only be found in the samples that were exposed to hydrogen – not in those exposed to helium. And that is what happened. As reported in the *Proceedings of the National Academy of Sciences*, Bradley's sensitive tests repeatedly found water, but only in the samples that were bombarded by hydrogen.

Martin McCoustra at Heriot-Watt University in Edinburgh finds the work convincing. He said: "I am not very surprised that water could be formed on silicates. However, now that they have shown that it can, it could be an important source of water."

Bradley's work implies that water molecules must have been forming for billions of years on interplanetary dust particles, on the Moon, and possibly on asteroids. However, McCoustra warns that "This source of water, albeit new, won't be able to account for a large proportion of water in the solar system. Most of that water was formed during the process of star formation that our sun went through."

Some have argued that water-rich comets planted water on our planet. But McCoustra reckons that a single-source is unlikely. And this study provides another potential source for the material that helps make our planet habitable.

More information: Paper: www.pnas.org/cgi/doi/10.1073/pnas.1320115111

This story is published courtesy of The Conversation *(under Creative Commons-Attribution/No derivatives).*

Source: The Conversation