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A Potent New Solid Rocket Propellant?

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The first rockets built in China during the 13th century AD used the then exotic solid propellant, gunpowder. Until Robert Goddard flew the first rocket to use liquid propellants in 1926, all rockets used some form of solid propellant. While the use of solid propellants has a number of advantages, liquid propellants have had an edge because they provided more thrust pound for pound than the best solid propellants. But this might change.

In the July 23, 1998 issue of the British science journal, Nature, David Jones discusses efforts to produce metallic hydrogen. For some time, scientists have used diamond anvil cells to exert millions of atmospheres of pressure on tiny samples of hydrogen. The hope is to produce a conductive, metallic phase of hydrogen like that which is believed to exist deep inside gas giant planets like Jupiter. While these high pressure experiments with hydrogen have yielded interesting insights, they have yet to produce the illusive metallic hydrogen for study.

In Nature's regular column, Daedalus, Jones speculates about another course that could be taken to produce a metallic phase with hydrogen. Instead of applying pressure to a sample of hydrogen, Jones proposes using a water-based solution of hydrogen. The result of this process is expected to be a "metallic ice" of hydroxonium ions (H_3O^+) in a sea of free electrons called hydroxonium. Unlike high-pressure phases of many materials, theory predicts that hydroxonium would remain stable possibly down to atmospheric pressures.

While there are a number of possible applications for hydroxonium (e.g. using it to produce new, lightweight alloys), one of the more interesting is as a rocket propellant. When heated hydroxonium decomposes, it should release a tremendous amount of stored energy. While detailed calculations have yet to be made, potentially hydroxonium could be more powerful than conventional liquid propellants. And with the exhaust products consisting of steam and hydrogen, hydroxonium would be environmentally cleaner than today's solid rockets.

While producing large quantities of solid hydroxonium would be difficult using diamond anvil cells, Jones speculates that there may be large quantities of this exotic metallic ice already available. Water and hydrogen are very common in the cosmos and nature may have already produced enormous amounts of hydroxonium in the cores of large icy bodies like comets and the moons of the outer solar system. While many visionaries have proposed mining such bodies to provide hydrogen to fuel interplanetary craft, perhaps mining hydroxonium would provide an even larger economic pay off and provide a potent propellant for continued exploration of the solar system.