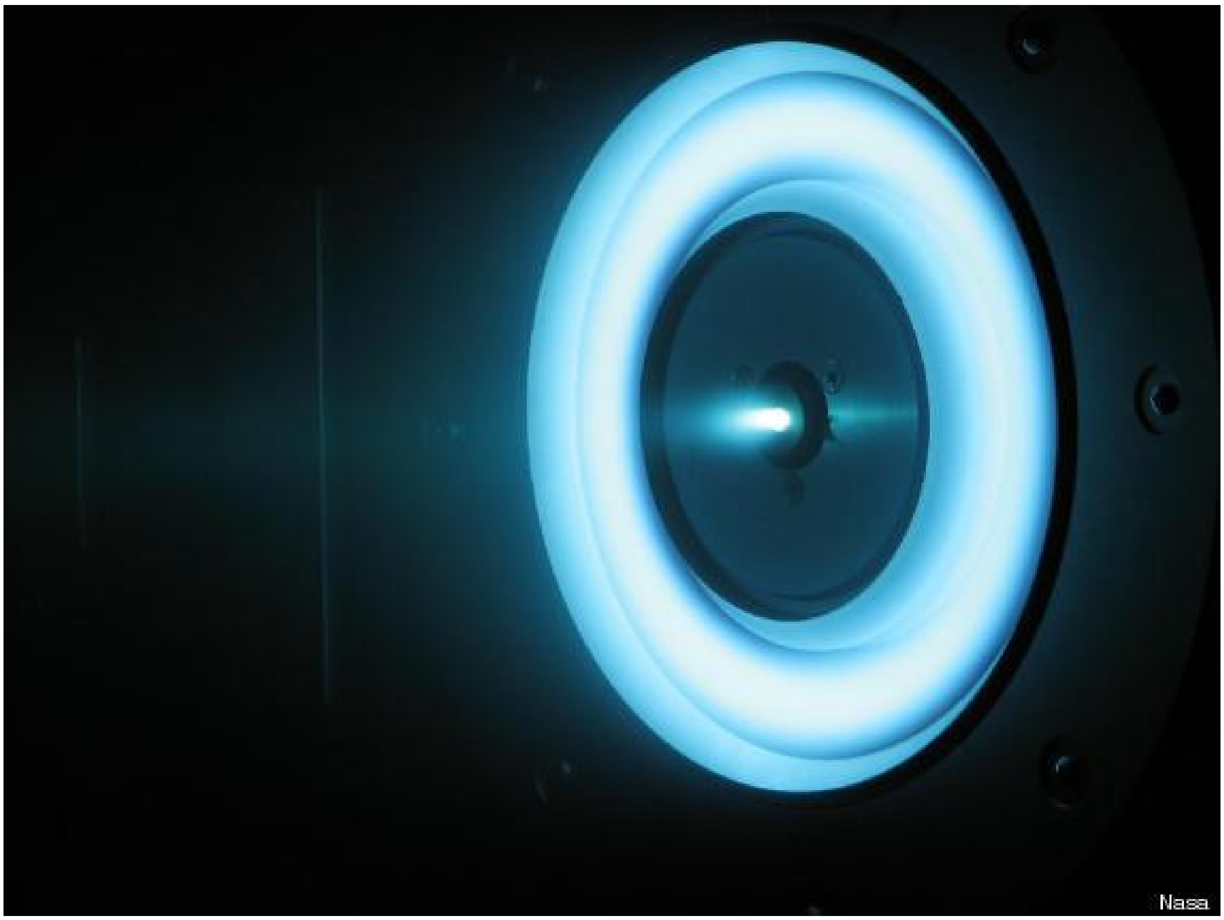
Ion propulsion—the key to deep space exploration

November 4 2015, by Evan Gough



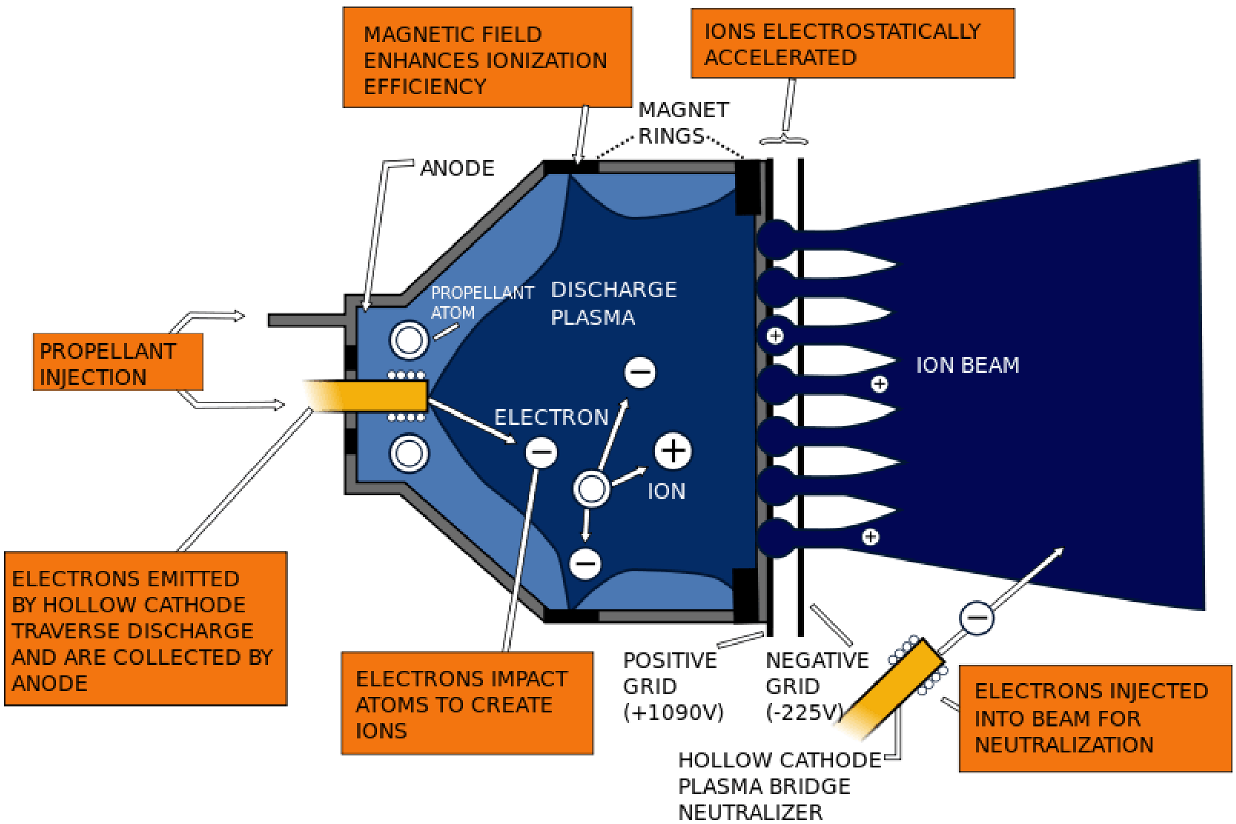
The comforting blue glow of an ion drive. Credit: NASA

When we think of space travel, we tend to picture a massive rocket blasting off from Earth, with huge blast streams of fire and smoke coming out the bottom, as the enormous machine struggles to escape Earth's gravity. Rockets are our only option for escaping Earth's gravity well—for now. But once a spacecraft has broken its gravitational bond with Earth, we have other options for powering them. Ion propulsion, long dreamed of in science fiction, is now used to send probes and spacecraft on long journeys through space.

NASA first began researching ion propulsion in the 1950's. In 1998, ion propulsion was successfully used as the main propulsion system on a spacecraft, powering the Deep Space 1 (DS1) on its mission to the asteroid 9969 Braille and Comet Borrelly. DS1 was designed not only to visit an asteroid and a comet, but to test twelve advanced, high-risk technologies, chief among them the ion propulsion system itself.

Ion propulsion systems generate a tiny amount of thrust. Hold nine quarters in your hand, feel Earth's gravity pull on them, and you have an idea how little thrust they generate. They can't be used for launching spacecraft from bodies with strong gravity. Their strength lies in continuing to generate thrust over time. This means that they can achieve very high top speeds. Ion thrusters can propel spacecraft to speeds over 320,000 kp/h (200,000 mph), but they must be in operation for a long time to achieve that speed.

An ion is an atom or a molecule that has either lost or gained an electron, and therefore has an electrical charge. So ionization is the process of giving a charge to an atom or a molecule, by adding or removing electrons. Once charged, an ion will want to move in relation to a magnetic field. That's at the heart of ion drives. But certain atoms are better suited for this. NASA's ion drives typically use xenon, an inert gas, because there's no risk of explosion.



Detail of an ion drive. Image: NASA Glenn Research Center. Credit: Vectorization by Chabacano

In an ion drive, the xenon isn't a fuel. It isn't combusted, and it has no inherent properties that make it useful as a fuel. The energy source for an ion drive has to come from somewhere else. This source can be electricity from solar cells, or electricity generated from decay heat from a nuclear material.

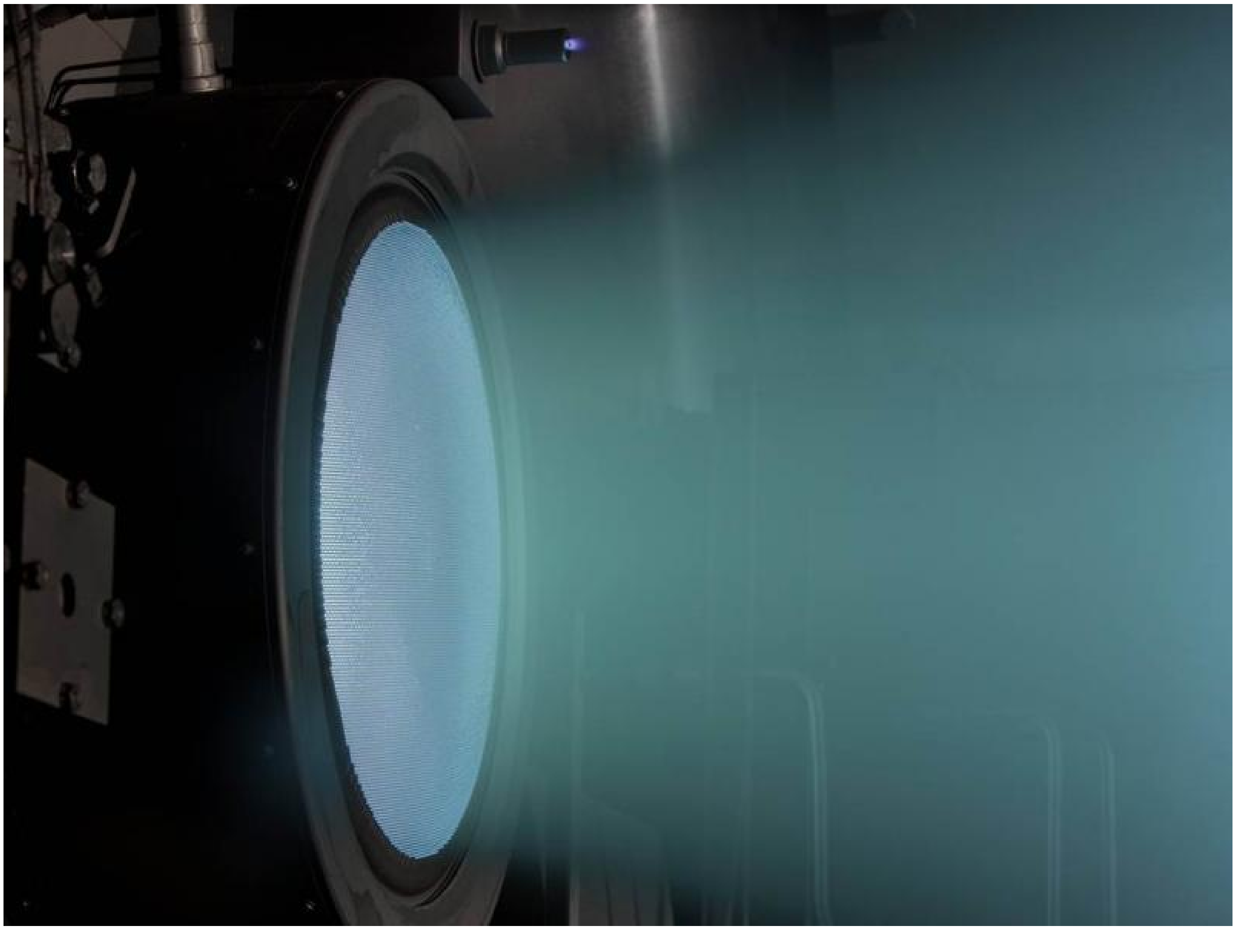
Ions are created by bombarding the xenon gas with high energy electrons. Once charged, these ions are drawn through a pair of electrostatic grids—called lenses—by their charges, and are expelled out of the chamber, producing thrust. This discharge is called the ion beam, and it is again injected with electrons, to neutralize its charge.

Unlike a traditional chemical rocket, where its thrust is limited by how much fuel it can carry and burn, the thrust generated by an ion drive is only limited by the strength of its electrical source. The amount of propellant a craft can carry, in this case xenon, is a secondary concern. NASA's Dawn spacecraft used only 10 ounces of xenon propellant—that's less than a soda can—for 27 hours of operation.

In theory, there is no limit to the strength of the electrical source powering the drive, and work is being done to develop even more powerful ion thrusters than we currently have. In 2012, NASA's Evolutionary Xenon Thruster (NEXT) operated at 7000w for over 43,000 hours, in comparison to the ion drive on DS1 that used only 2100w. NEXT, and designs that will surpass it in the future, will allow spacecraft to go on extended missions to multiple asteroids, comets, the outer planets, and their moons.

Missions using ion propulsion include NASA's Dawn mission, the Japanese Hayabusa mission to asteroid 25143 Itokawa, and the upcoming ESA missions Bepicolombo, which will head to Mercury in 2017, and LISA Pathfinder, which will study low frequency gravitational waves.

With the constant improvement in ion propulsion systems, this list will only grow.



NASA Evolutionary Xenon Thruster. Credit: NASA

Source: Universe Today

Citation: Ion propulsion—the key to deep space exploration (2015, November 4) retrieved 25 April 2024 from https://phys.org/news/2015-11-ion-propulsionthe-key-deep-space.html