

Ion Propulsion

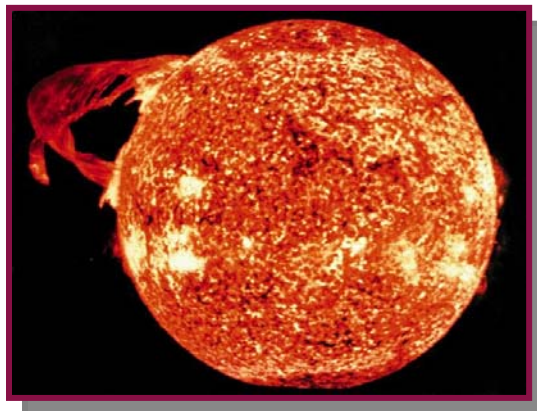
Powered by the Sun

STUDENT READING

The Dawn spacecraft will utilize an ion propulsion engine on its long journey to the asteroid belt. As explained in other sections of this module, the engine requires energy to ionize xenon, the fuel. In addition energy is needed to produce charge on the engine's screens and to run other spacecraft systems. Where will this energy come from? Surely a brief moment of thought will lead you to the conclusion that batteries will not suffice to provide the necessary power for the multi-year flight. While a battery will be on the spacecraft, it will not be involved directly in the propulsion system. Instead, the propulsion system will be powered by the Sun. That is, the required electrical power will be generated from a solar array located on each side of the spacecraft bus, each of which extends approximately 10 meters in each direction from the spacecraft.

The solar cells on the arrays are made of several layers of materials, including Indium, Gallium, Phosphorus, Arsenic and Germanium (InGaP, InGaAs, and Ge) and they operate at roughly 25% efficiency. Each solar array can be rotated around its long axis (the y axis) and the spacecraft keeps y perpendicular to the line connecting the Sun to the spacecraft. To make sure that the highest possible power is produced, the spacecraft rotates the arrays around their long axes in order to maximize exposure of the solar cell surfaces to the Sun's rays. The power produced by the arrays depends on the distance of the spacecraft from the Sun. Roughly speaking, they will generate 10 kW at 1 AU (the average distance from the Earth to the Sun) and 1.3 kW at 3 AU (approximate distance to Ceres).

Now let's return briefly to the need for a battery on the spacecraft. During the launch the entire spacecraft is run from the battery and this continues until it is able to deploy its solar arrays and point them at the Sun. Then during thrusting of the engine at some distance from the Sun, the arrays will provide the power. Should there be a need for "extra" power for a few minutes to turn on a device such as a heater, the battery can be called upon to cover this temporary increase in power consumption. When the device goes off, any excess power from the arrays is used to recharge the battery.



Sun
NASA/JPL