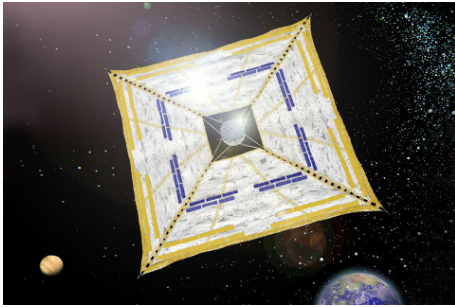


## 1 Solar Sail



The first spacecraft using a solar sail for propulsion was launched in 2010. Its name is IKAROS. It has a square sail with dimensions 14 m x 14 m. Assume that the sail's mass is 2 kg and it reflects 100% of incident photons. When IKAROS is loaded with other equipment, the total mass of the vehicle is 10 kg. The sail is orientated to receive maximum light from the sun.

- (a) Calculate the momentum of the photons that come from the sun and hit the solar sail in 1 second. Assume a solar intensity of  $1300 \text{ J}/(\text{s}\cdot\text{m}^2)$ .
- (b) How much momentum will be transferred from solar photons to IKAROS in one day? Give a numerical answer in units of  $\text{kg}\cdot\text{m}/\text{s}$  (assume a constant solar intensity).
- (c) What is the change in the solar sail's velocity in one day? (assume that acceleration is only caused by sunlight).

## 2 Human Vision

*None (Q4M.5 from textbook)* Suppose you are standing in the dark and facing a 20 W LED bulb 100 m away. If the diameter of your pupils is about 8 mm under these conditions, about how many photons of *visible* light enter your eye every second?