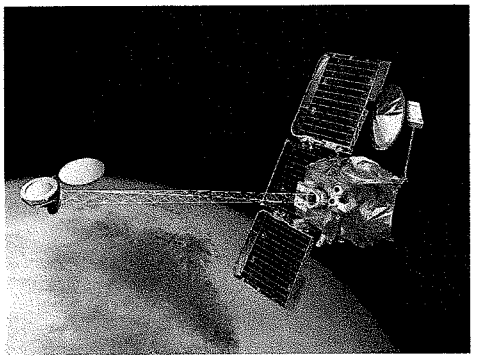
Gamma Ray Photons and Neutrons from Mars: Student Reading

Introduction



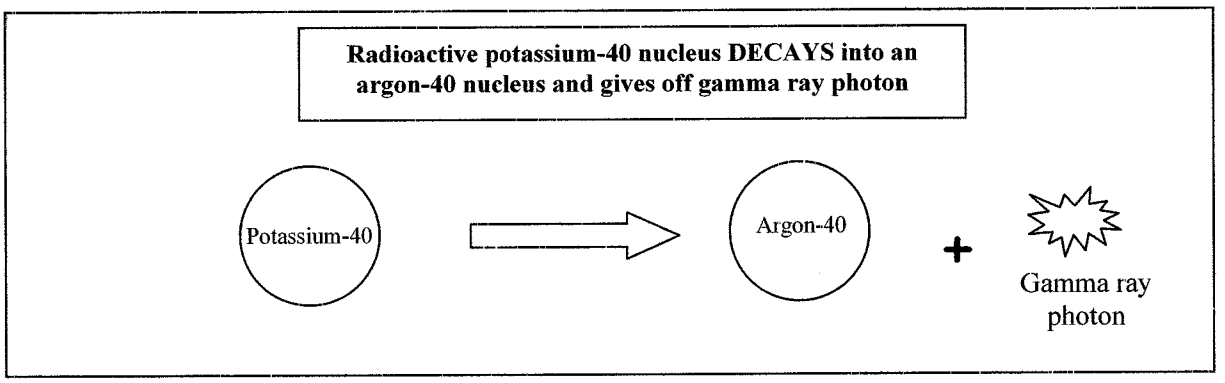
The Mars Gamma Ray Spectrometer (GRS) is currently orbiting Mars aboard the Mars Odyssey spacecraft. GRS, shown on its extended boom in the image to the right, detects neutrons and gamma ray photons coming from the surface Mars. In this activity, you will learn why Mars gives off these particles and find out how we can use them to learn about what the surface of Mars is made of.

Neutrons and Gamma Ray Photons

First, let's talk about what neutrons and gamma ray photons are. A neutron is a particle that is similar in mass to a proton but with no charge. The center, or nucleus, of an atom is made of protons and neutrons. A gamma ray photon is a high-energy packet of light, or electromagnetic radiation. Just as our eyes or visible cameras can detect visible photons, gamma ray detectors such as Mars GRS can detect gamma ray photons. The two main reasons that gamma rays and neutrons are given off by Mars are described below.

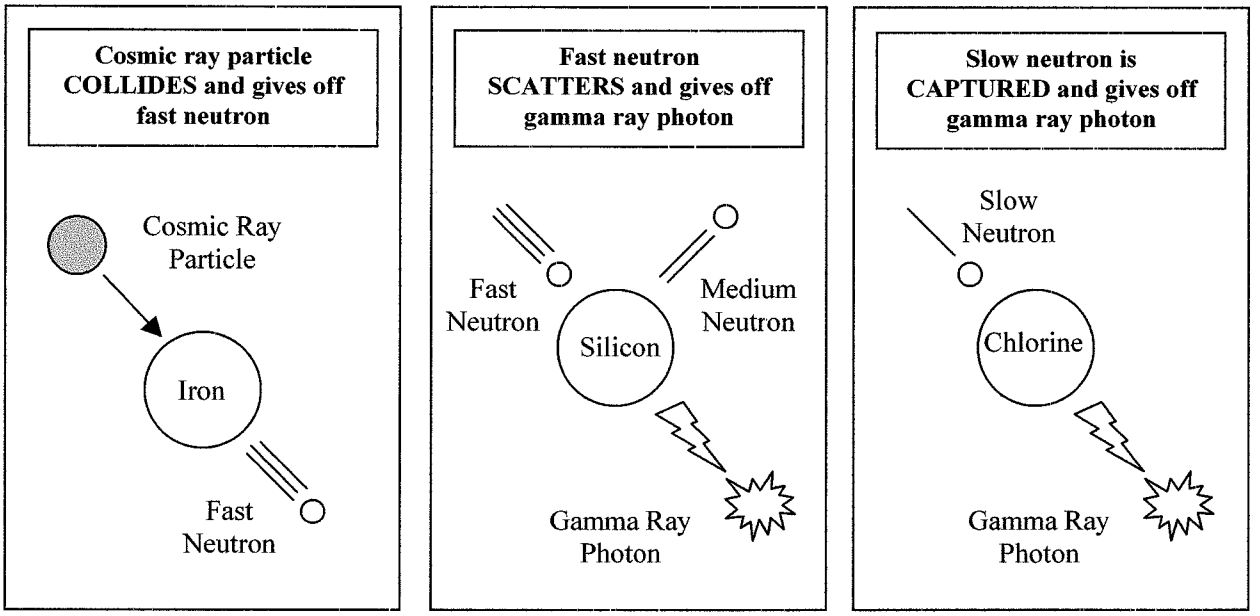
Radioactive Decay

One way that gamma rays are produced at the surface of Mars is through radioactive decay. When unstable radioactive elements such as potassium, thorium, and uranium decay into other elements, they can give off gamma ray photons with specific energies (see diagram below). For example, when potassium-40 decays into argon-40, a gamma ray photon of a specific energy is released. We will call this a "decay event." Detection of gamma ray photons with this energy as Mars GRS flies over a part of Mars indicates the presence of potassium in that region.



Cosmic Ray Particle Bombardment

Neutrons and gamma ray photons can also be made when the surface of Mars is bombarded by cosmic ray particles. Cosmic ray particles are high-energy hydrogen and helium nuclei that race throughout outer space at exceptionally high speeds. When one of these particles smashes into the surface of Mars, the atoms that it strikes give off fast moving neutrons. These fast neutrons can then either escape from the planet or interact with other atoms at the surface of the planet. The cartoon sketches below show these interactions. In the first drawing, a cosmic ray particle collides with a target atom (in this case iron) and gives off a fast neutron. We will call this a "collision event." In the second drawing, a fast neutron bounces off of a target atom (in this case silicon) and slows down to a medium neutron. We will call this a "scatter event." A gamma ray photon of a specific energy is given off. In the final drawing, a slow neutron is captured by and excites a target atom (in this case chlorine), which then gives off a gamma ray photon of a specific energy. We will call this a "capture event."



Figuring Out What Mars Is Made Of

As Mars GRS orbits Mars, it detects neutrons and gamma ray photons given off by the processes described above. Because every element (for example, iron, silicon, chlorine, hydrogen) gives off gamma ray photons of specific energies, we can figure out the concentration of these elements based upon the energies of photons that are detected. Also, because we understand how neutrons interact with these elements, we can learn about the composition of the surface based upon the energies of the neutrons we detect.

Gamma Ray Photons and Neutrons from Mars: Student Questions

Answer the following questions based upon the student reading.

1) Give two characteristics for each of the following particles:

Particle	Characteristic 1	Characteristic 2
Neutron		
Gamma Ray Photon		
Cosmic Ray Particle		

2) List the four types of "events" described in the reading?

3) Which of these types of events will NOT be affected by an increase in the number of cosmic ray particles striking the surface of Mars. Justify your answer.

4) If Mars GRS detects an increase in gamma ray photons specific to hydrogen when it is orbiting over a particular region of Mars, what might this tell us about the composition of the surface in that region?