PLANETARY PHYSICS

Jupiter: Gravitational Energy

Gravitational energy generated when Jupiter contracts about one-fiftieth of an inch per year is the source of the tremendous energies this giant member of the solar system is radiating.

Recent measurements have shown that Jupiter emits up to three times as much energy as it receives from the sun, an amount equal to one 1,000 megaton hydrogen bomb per second.

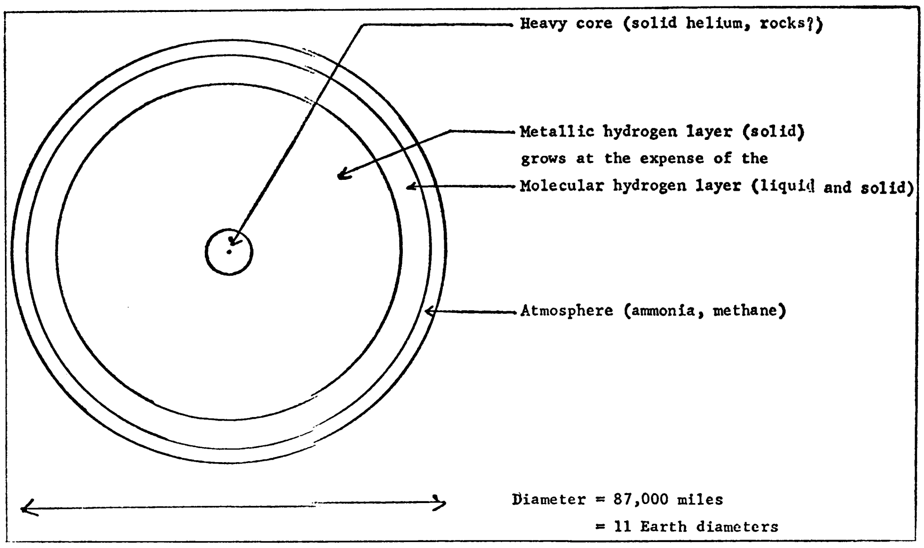
After considering possible sources of this energy, Dr. Roman Smoluchowski, a solid state physicist at Princeton University, concluded it could result only from a net shrinkage of the planet by a fiftieth of an inch each year, which means that the enormous emission can continue for tens of billions of years, before the planet collapses.

Dr. Smoluchowski then asked himself what would make a planet shrink. The answer he reported to the American Physical Society meeting in New York is a progressive change of Jupiter's outside layer of hydrogen from a less dense molecular form to a more dense metallic form, with consequent slight shrinkage.

Among the energy sources Dr. Smoluchowski considered and then ruled out were:

- Heat generated by decay of radioactive elements, the cause of earth's hot interior. On earth, potassium is a main source of radioactive heat because it is so wide spread, although uranium and thorium also contribute. On Jupiter, Dr. Smoluchowski calculated, these three elements fail by a factor of 100,000 to contribute sufficient energy to account for the planet's measured radiation.
- The fusion of hydrogen atoms into helium, the thermonuclear reactions by which the sun is stoked and which man has achieved in hydrogen bombs. Fusion occurs only at extremely high temperatures, and Jupiter's temperature is 70 times too low for fusion. Jupiter is so big that it makes up 70 percent of the mass of all the planets combined, although it consists mainly of the lightest known elements—hydrogen and helium. Both are usually gaseous. Hydrogen, which on Jupiter is about four times as abundant as helium, exists there under pressures up to tens of millions of atmospheres.

Under these conditions, some of the hydrogen becomes liquid. Most of it, however, is solid; partly as a molecular insulator at intermediate depths and partly as a conducting metal closer to the planet's center. Although liquid and solid molecular hydrogen are obtainable in laboratories, the metallic form that was predicted theoretically by Drs. Eugene Wigner and Hillard B. Huntington of Princeton requires pressures beyond those possible with present techniques.



Shrinkage, hydrogen transformation account for Jupiter's energy emission.

Nevertheless Dr. Smoluchowski has calculated that the liquid form of hydrogen may account for Jupiter's strong magnetic field. Slight mixing of these two forms of solid hydrogen is the reason Jupiter emits so much energy—20 times what the earth receives from the sun.

The large amounts of radiation from Jupiter were first recorded in long wave lengths by Dr. Frank Low of the National Radio Astronomical Observatory.

HIGH ENERGY PHYSICS

Emperor Paying Off

Once the experiments are understood, new insight into how two colliding units of complex nuclear matter interact is expected to be provided by the Emperor tandem Van de Graaff accelerator that started operation at Yale University last summer.

It provides a unique precision that allows scientists to "reassemble the components of the nucleus and nudge them around a bit," in the words of Dr. D. A. Bromley, Yale physicist.

At the American Physical Society meeting in New York last week, Dr. Bromley reported initial results of nuclear probing with the Emperor accelerator for the first time.

He said preliminary evidence suggests that when two oxygen atoms smash into each other, under certain conditions a helium nucleus may disengage itself from one of the heavier oxygens and bounce back and forth between the two colliding nuclei, like a ping ball between two billard balls.

He related this behavior in the nuclear world to the minuet danced by the electron in its array of energy states, but that further studies are needed before any precise explanation can be offered.

The performance of the accelerator system has surpassed original expectations, demonstrating a range and control of projectile energy beyond those of any previous electrostatic accelerator.

The Yale research groups have used proton and deuteron beams in the energy range from 1.8 to 25.5 million electron volts, oxygen beams in the energy range from 10 to 80 million electron volts.

The first tandem accelerator was installed at Canada's Chalk River laboratories in 1959. Recognizing the need for higher energies in the intervening years, a number of laboratories installed larger models of the accelerator, which became known as "King" tandems. When the much larger Yale accelerator was designed, the "Emperor" designation was a natural.