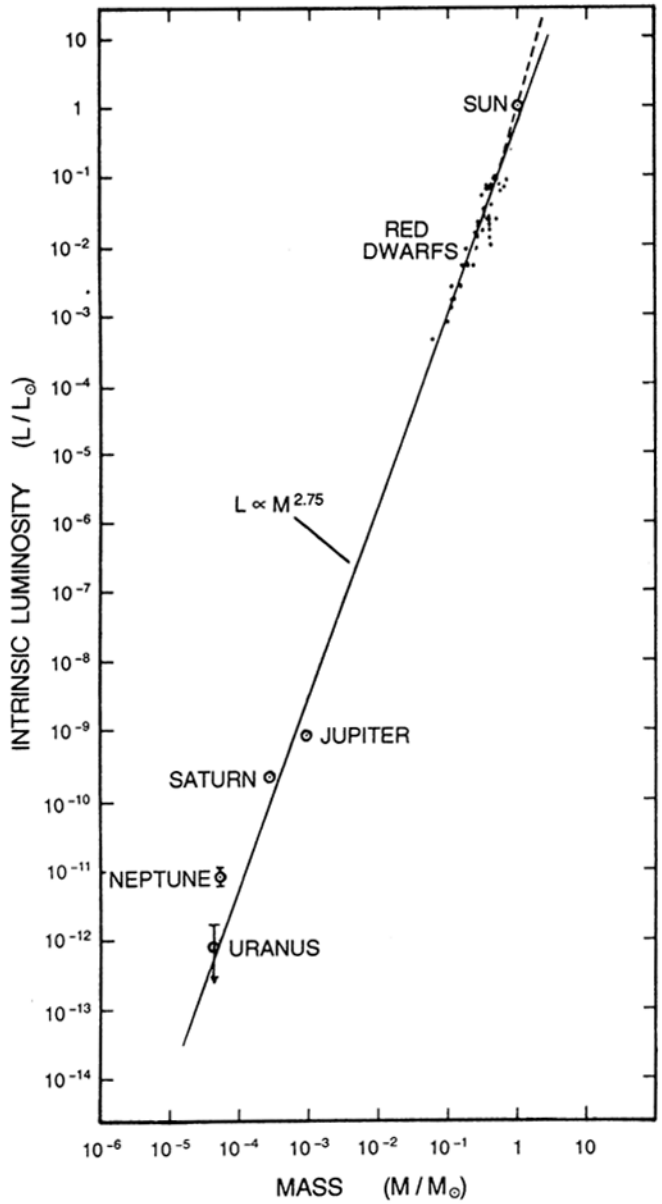

Figure 2. The position of the planets shown in relation to an extension of the lower main sequence stellar mass-luminosity relation.

luminosity values for several planets have been plotted in Fig. 2. As is seen, these planetary mass-luminosity points fall quite close to the stellar relation. This correspondence was first discovered in 1978 in checking out this genic energy prediction. Brown dwarfs and planets having masses less than $0.08\ M_{\odot} (L < 5 \times 10^{-4}\ L_{\odot})$ are conventionally assumed to derive their radiated energy from a store of primordial heat acquired as a result of gravitational collapse and accretion. Accordingly, the luminosity of such a body would be expected to constantly decrease in the course of its approach to thermodynamic equilibrium, the main factor governing its luminosity being the amount of time elapsed since its initial formation. Hence the mass-luminosity coordinates for such objects would not necessarily be expected to coincide with the main sequence mass-luminosity relation. On the basis of conventional theory, it is quite unexpected to find the mass-luminosity coordinates of the Jovian planets falling so close to the stellar relation. Ascribing their luminosities solely to primordial heat would suggest that we are observing them at a time in their cooling histories when they all fortuitously coincide with the stellar mass-luminosity relation.

Table I: Intrinsic Luminosities for the Jovian Planets, Earth, and Moon.

Planet	*Wavelength* (μm)	*Bond Albedo*	L_{int}/L_{sun}	$\log L_{int}$ (erg/s)
Jupiter	$2-50$	0.34 ± 0.03	0.67 ± 0.09	24.53 ± 0.03
Saturn	$2-50$	0.34 ± 0.03	0.78 ± 0.09	23.94 ± 0.03
Uranus	$2-50$	0.39 ± 0.05	0.06 ± 0.08	21.53 ± 0.33
Neptune	$2-50$	0.31 ± 0.04	1.6 ± 0.3	22.52 ± 0.04
Earth	...	...	...	20.60
Moon	...	...	...	18.84

The luminosities for Jupiter, Saturn, Uranus, and Neptune are from the *Voyager* infrared data.(14) Table I lists the infrared spectral range observed, the value adopted for the planet's surface albedo, the ratio of the planet's intrinsic luminosity to energy flux received from the Sun, and the log of the planet's intrinsic luminosity. Intrinsic heat measurements for the smaller planets have been made only for the Earth and Moon, in this case by directly measuring their subsurface thermal gradients with implanted probes. *Voyager 2* has found indirect evidence of an internal heat source on the surface of Neptune's moon Triton, in the form of a liquid nitrogen geyser spouting from Triton's frozen nitrogen surface. According to subquantum kinetics, this geothermal geyser would be powered by the same type of energy that powers Jupiter's red spot and Neptune's brown spot – genic energy.

Adiabatic cooling models predict a temperature and luminosity close to Jupiter's observed value for a cooling time comparable to the age of the solar system ($t \sim 4.5$ billion years).(15–18) However, adiabatic cooling has greater difficulty explaining Saturn's thermal output. A cooling model similar to Jupiter's accounts for only about half of Saturn's observed luminosity. For cooling to account for all of its output, Saturn would have to be unusually young, about 2.8 ± 1.2 billion years old.(19,20) To resolve this problem, alternate energy generation mechanisms have been proposed. One suggests that Saturn is releasing heat as a result of a gradual contraction process.(21) Another suggests that it is releasing heat as a result of the phase separation and gravitational settling of He from an initially uniform H–He mixture.(21–23)

Uranus and Neptune also present problems for the standard adiabatic cooling model. In this case the observed intrinsic luminosities are low compared with expected cooling model values. As a possible explanation Hubbard and MacFarlane(24) have suggested that these planets had low luminosities at the time of their formation, only a few times higher than their present luminosities. However, such a scenario requires that the circumstances surrounding the formation of these two planets were substantially different from those involved in the formation of Jupiter and Saturn, for which initial luminosities on the order of 10^6-fold higher are usually proposed.(16) Alternatively, Stevenson(20) has suggested that a cooling mechanism may be in operation in these planets, whereby an initially density-stratified planetary interior becomes homogenized, and hence cooled, as a result of convection.

Jones *et al.*(25) have proposed that cold nuclear fusion might be the