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THE OCEANS OF PLUTO

Ken Tapping, 5th July, 2016

Just about a year ago the New Horizons spacecraft flew past Pluto. It showed us a world like nothing we had expected. Out there in the cold, dark outer reaches of the Solar System, we expected Pluto to be a deep-frozen ball of rock and ice, unchanged over billions of years, apart from a long history of being cratered by collisions with other objects. We had made temperature measurements. During the Plutonian winter, temperatures fall to about –240 C, and in summer, they rise to a not-very-balmy –220 C. Our main interest in Pluto was due to our idea that it would have changed little since the birth of the Solar System, and would be a preserved sample of the primordial material from which the Sun and other bodies formed. We were wrong.

As the spacecraft approached Pluto, and the images got more and more detailed, it became clear that Pluto was very different from what we expected. Instead of an icy, rocky ancient surface covered with craters we saw great areas with no craters, and other areas that were cratered, but relatively few of them. Pluto's surface is not ancient; it is geologically young, and still changing.

One area that really stood out was a large, pinkish plain, which has been provisionally named "Sputnik Planum", the "Plain of Sputnik", after the first manmade satellite to orbit the Earth. It was covered with huge polygon-shaped tiles, separated by grooves. At the edge of the plain, where it met the surrounding mountainous terrain, there were features that looked like the broken and refrozen masses of ice we see on the seashore or on Canadian lakes in winter, where the tide or wind piles up ice on the shore. The tiled appearance looked very like the surfaces we see in the Canadian Arctic, where the ground overlying permafrost has repeatedly melted and refrozen. It also resembles the frozen tops of convection cells, like the ones we see in a pot of heating cooking oil. This leads to a surprising conclusion; the surface of Pluto is not permanently frozen. It is melting, rearranging and freezing again. This raises two questions: what material is melting and re-freezing, and where is the heat coming from?

In the Canadian Arctic the terrain is moulded by the melting and refreezing of water. However, on Pluto the temperatures are so low that water is a permanently solid rock mineral. The best candidate is nitrogen. There is a lot of it on Pluto and at the temperatures on that world, it would be a solid. The melting point of nitrogen is –210 C. It is possible that on particularly warm days the nitrogen would melt, or at least become a soft, semi-molten slurry. That would explain the glacier-like features we see. However, it is likely that the Sputnik Plain is not a plain at all; it is the frozen cover of an ocean. In addition, the complete lack of craters on the Sputnik Plain suggests that the cover is not permanently frozen; it melts sometimes. However, even the Plutonian summers are not really warm enough, and to have a molten ocean below that icy cover requires some heat to be applied from below, at the seabed.

The most likely candidate is heat released in its core by the decay of radioactive elements collected when Pluto formed. Since these elements are usually dense, they tend to accumulate in the core, where they produce heat. Such elements contribute to our world having a molten core. Heat from the bottom of Pluto's ocean melts the nitrogen into a liquid or slurry, which convects to the surface, forming those huge polygons. Due to its great distance from us, the spacecraft signals are very weak and the information is being sent back very slowly, so it is likely that more surprises will be coming.

Jupiter is descending in the west, and Mars and Saturn lie in the southern sky. Mars is the bright one; Saturn is fainter and to Mars' left. The Moon will reach First Quarter on the 11th.

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