LETTERS

Pretty vacant

Nigel Henbest reports that the Wake Shield—a giant saucepan lid free-flying behind the shuttle Columbia—"has smashed all records for a human-made vacuum". This centrepiece of an otherwise engaging article is unfortunately wrong ("Into the void", 25 April, p 26). The figure quoted for the vacuum created by the Wake Shield is greatly exaggerated. Moreover, it is easy to make a vacuum on Earth that is much better even than that hoped for from the Wake Shield.

Henbest correctly uses the average spacing between the residual molecules in the vacuum as a measure of its quality and reports that the average spacing between molecules behind the Wake Shield is about 1 millimetre. Actually this is what was hoped for, not what was measured. A mass spectrometer similar to that used to measure the vacuum on the Moon found that the average spacing of water molecules varied during the flight, but was typically only 14 micrometres—rather a poor vacuum by normal Earth standards.

Moreover, vacuums are easily created here on Earth that are even better than the unrealised hopes for the Wake Shield. A conventional vacuum pump is used to pump the air out of a container, which is then closed and cooled to a temperature of 4·2 kelvin (the boiling point of liquid helium at atmospheric pressure). This creates a vacuum where the theoretical spacing between residual molecules (neglecting the effect of occasional cosmic rays) is nearly 1 kilometre.

This way of obtaining a good vacuum is called cryopumping. By cooling to below 0·1 kelvin, which is easily achieved with a dilution refrigerator, the vacuum can be better still.

The real challenge on Earth, as in space, is to measure the spacing between molecules when there are so few of them. The best commercial vacuum gauges are not nearly sensitive enough.

Some years ago we used antiprotons, the antimatter counterpart of protons, as an extremely sensitive vacuum gauge and showed that the average spacing of molecules within our 4·2 kelvin container was greater than 2 millimetres. In theory, the vacuum should be much better, but even our improved antiproton vacuum gauge was not sensitive enough to tell.

Gerald Gabrielse
Harvard University
Cambridge, Massachusetts