DARREN HOPES

GHOST BUSTERS

The universe is full of dark spectres – but could a simple change to our cosmological outlook exorcise them, asks Stuart Clark

A DOOR flies open but no one's there. A vase levitates from the mantelpiece and hurls itself across the room. The furniture starts moving around of its own accord.

The universe today is a little like one of those ghost movies. Galaxies whirl around in unexplained ways. Groups of stars race across space, pulled by forces from beyond the visible universe. The fabric of space is inexplicably elastic, expanded ever faster by an inscrutable energy all of its own.

Not an overly superstitious bunch, cosmologists invent names for the poltergeists responsible – dark matter, dark flows, dark energy – and invest a lot of effort in proving they are real. But might they, too, be chasing ghosts? That's what some of their ilk say. They argue that the standard model of the universe is based on an oversimplification of Einstein's general relativity – the theory that underpins all of cosmology – and contains an unwarranted assumption about how stuff is distributed in the universe. Strip away these misconceptions and we can exorcise the cosmos of its uninvited manifestations. Is this for real?

Arguments today about the nature of the cosmos begin and end with Einstein. His equations of general relativity describe how matter curves space and time around it, causing the local accelerations we interpret as the force of gravity and, on the grandest scale, guiding the universe's evolution. Over the past century, cosmologists have plugged their improving observations into Einstein's equations and, little by little, refined the standard model. So here we are, in a universe that began some 13.8 billion years ago as an unimaginably hot, dense pinprick that has since been uniformly expanding and cooling in all directions.

To make Einstein's fiendishly complex equations tractable and arrive at such conclusions, however, a few simplifying assumptions must first be hard-wired into the model. One has a particularly distinguished pedigree. When Nicolaus Copernicus laid out the Copernican principle in the 16th century, it was to say that Earth was not the centre of the universe. In modern cosmology, it has morphed into the cosmological principle: that Earth is nowhere special at all. We see the universe from a representative standpoint, and draw conclusions that can apply everywhere else, too. This amounts to two related assumptions. First, that the universe is homogeneous, looking roughly the same in all locations. Second, it is isotropic, looking roughly the same in all directions from any standpoint.

For some, this is a leap of faith. In the universe today, galaxies exist in clusters and filaments of matter distributed around the boundaries of huge, bubble-shaped voids. These voids have roughly one-tenth of the clusters' matter density, but account for more than 60 per cent of the universe's volume. "Everyone knows that the universe is inhomogeneous," says Thomas Buchert of the University of Lyon in France. "To idealise such a complex structure with a homogeneous solution is a bold idealisation."

The mismatch is generally brushed aside using the concept of statistical homogeneity: that the sort of universe we are looking for exists if we zoom out far enough. On scales of about 400 million light years, bigger than all the structures we see, voids and galaxy clusters average into uniformity.

The problem is, we don't have a bird's-eye view of the universe on such scales. David Wiltshire, a cosmologist at the University of Canterbury in New Zealand, thinks that what is going on right in front of our eyes might be distorting our view.

He has been looking at the cosmic microwave background (CMB), light produced when photons scattered off the first atoms formed some 380,000 years after the big bang. This light has since been travelling with the cosmos, expanding and cooling along with it. In a uniform universe, the same amount of expansion and cooling should have taken ›