PROFILE

Matt Visser

Professor Matt Visser is very well-known internationally for his contributions to general relativity, gravitation, and quantum field theory in curved spacetime.

Matt completed his undergraduate degrees at Victoria University of Wellington before heading to the University of California, Berkeley, as a Fulbright-Hays Scholar in 1978. His PhD thesis completed in 1984 was on *"Aspects of Supersymmetry Breaking"*, under the supervision of Professor Mary K Gaillard. He remained in the USA for his postdoctoral career, on a trajectory that took him to the University of Southern California, Los Angeles 1984–1987 and Los Alamos National Laboratory 1987–1989. In January 1990 he moved to the University of Washington, St Louis, Missouri, where he worked for over 12 years before returning to Victoria University of Wellington in July 2002. Matt was initially appointed as Reader, and soon promoted to Professor four years later.

Matt has made numerous contributions on supergravity, black holes, Hawking evaporation (of black holes), gravitational thermodynamics, cosmology, brane worlds, quantum gravity and in fact anything to do with gravity that is worth doing! But he is perhaps best known for his work in two fields: (i) wormholes; and (ii) analogue models of gravity.

Wormholes are hypothetical solutions of the gravitational field equations which connect different asymptotic regions, providing shortcuts in space-time. If they existed, then of course they would be great for interstellar travel. However, they are the stuff of science fiction on account of the fact that to hold the throat of a wormhole open one generally needs forms of matter that violate energy conditions in general relativity. The energy conditions — another of Matt's interests — tell us what we might expect of physically reasonable matter: its energy density should be positive (so that a lower bound ground state exists), its equation of state should be such that the speed of sound is no greater than the speed of light, etc.

Although long-lived wormholes which violate the energy conditions seem to be forbidden in the real Universe, in quantum gravity there is a chance that we might violate energy conditions for small time intervals as allowed

by the uncertainty principle. This makes wormholes objects of interest for quantum gravity, and also for the fundamental problems relating to causality since wormholes generically allow for the possibility of closed timelike loops, that is: time machines!

Stephen Hawking had a famous "chronology protection conjecture" to deal with all the issues raised by closed timelike loops in general relativity. At Stephen's 60th birthday symposium in January 2002, Matt was invited to speak on *"The quantum physics of chronology protection"* as the acknowledged world leader on this topic.

Matt's book *"Lorentzian Wormholes: From Einstein to Hawking"*, published in 1996 and publicity from the 1996 BBC Horizon documentary *"The Time Lords"*, have also meant that Matt has had more than his fair share of crackpots to deal with. This included one individual who e-mailed him to say: *"Professor Visser, I need help. Space aliens are communicating with me through wormholes embedded in my brain."* And who can forget the phone calls from Leon, the anti-Christ, based somewhere in Australia.

The other topic on which Matt is possibly the world's best expert is analogue gravity: seeking physical systems, including fluids and condensed matter systems such as Bose-Einstein condensates, where one can investigate physical processes which are analogous to those of quantum fields in curved spacetime: Hawking evaporation, or particle production in an expanding universe. In the case of Hawking evaporation one requires a condensed matter system in which there are distinct causal domains due to the finite speed of sound, analogously to black hole horizons originating from the finite speed of light. While Matt has pioneered the mathematical physics and the analytic techniques used in this field, it has now matured to the extent that laboratory experiments are being performed.

Matt has written a lot about black holes, including the Kerr geometry. Matt's introductory chapter for the *"The Kerr Spacetime"* (2009), (which he and I co-edited along with Susan Scott), is by now the first port of call for many graduate students embarking on their study of these intriguing objects. Gravitational waves have now been detected from black hole mergers, ushering in a new era of gravitational wave astronomy. The contributions of many black hole physicists and mathematicians, including Matt, are going to be central in this new age of discovery.

Matt is a prolific researcher with over 200 published journal articles. He was elected a Fellow of the Royal Society of New Zealand in 2006, a Member of the Foundational Questions Institute (FQXi) in 2007, a Fellow of the American Physical Society in 2009, and a Fellow of the New Zealand Institute of Physics (NZIP) in 2011. He has held four Marsden grants as Principal Investigator, and a James Cook Fellowship of the RSNZ 2012–2013. He was awarded the Dan Walls Medal of the NZIP in 2013, its highest honour. Matt has also served on the editorial boards of *Journal of Physics A* (2008–2014), *Proceedings of the Royal Society A* (2012–2015), and *Physical Review Letters* (2012–current), and is the moderator of gr-qc at arxiv.org — an important service to the community that he has performed for over 20 years.

Following Stephen Hawking's passing last month, the world is now remembering his legacy. Many questions Hawking investigated in quantum gravity and cosmology are still open and still very challenging. Matt Visser is one of those at the forefront of probing our understanding of the fundamental mathematical physics of how and why the Universe works the way it does.

David L. Wiltshire