A Moment With…

Dr. Claudia de Rham

by Philip Mozel, Mississauga Centre (phil.mozel@sympatico.ca)

From the southern location of Madagascar, all of the big-ticket items of the night sky— the Magellenic Clouds, Omega Centauri, and the Tarantula Nebula for instance — are available in all their glory to the skywatcher. The centre of the Milky Way passes high above. And the sky is dark! One can literally see the mysteries of the Universe spread out overhead. After spending a portion of one's youth with such a nightly sky show, it is not surprising that the stars beckon — as they did with Dr. Claudia de Rham.

Born in Switzerland, Dr. de Rham attended the French High School of Tananarive on Madagascar. She then studied at the Swiss Institute of Technology, the Ecole Polytechnique in Paris, and Cambridge University in the UK, obtaining a Ph.D. in cosmology, and beginning a globetrotting career. She is currently doing postdoctoral work in cosmology at McMaster University in Hamilton and the Perimeter Institute for Theoretical Physics in Waterloo. Cosmology, with its mysteries and interesting puzzles, was a logical subject of study, following naturally from her interest in physics, and those tremendous Madagascar skies. Not only has Dr. de Rham studied around the world, she has worked in a wide variety of locations, including as an intern at the Geophysical Observatory at Tananarive on Madagascar. While providing assistance to researchers there, she managed to obtain time on the observatory's telescope whenever it became free. She helped students at the African Institute of Mathematical Studies obtain their Masters degrees and, while an undergraduate at the Science Museum in Lausanne, Switzerland, helped to develop a teacher's guide for an exhibition dealing with the properties of light. During a sojourn as an intern at the Jet Propulsion Laboratory, she worked on Mars topography and looked for correlations between the planet's gravitational and magnetic fields.

This is a lot of moving around, and, when asked if this was largely planned, Dr. de Rham replies, "No, it just turned out that way." Since nothing has attached her permanently to one place, the notion of the whole world as her home developed naturally. She has certainly seen this world from various angles — from the back of a horse while show jumping, flying above it as a student pilot, or diving beneath it as a master diver.

By this point in the interview, I was ready, sort of, to ask about Dr. de Rham's research specialty. There was some apprehension on my part because the subject seemed just about unfathomable. Dr. de Rham was, thankfully, very patient as I simply and directly said, "Please explain braneworld cosmology."

Dr. Claudia de Rham

It turns out that this involves multiple dimensions, both seen and unseen. Our world is composed of three spatial dimensions plus one of time. This is all we can physically experience, as far as dimensions go. If other dimensions exist, they may be too small to see. This would be analogous, Dr. de Rham explains, to "every point in space being seen as a circle of such small radius that we would perceive them as simple points."

Invoking extra dimensions may allow the unification of all the fundamental forces, *i.e.* the weak force, strong force, electromagnetism, and the so-far-recalcitrant gravity, the weakest of the four. According to braneworld cosmology, our Universe consists of a three-dimensional "brane" embedded in a higher-

dimensional space-time called the "bulk." The Big Bang, for example, could be explained as the collision between two branes. The weakness of gravity, propagating as gravitons, is explained as due to gravitons leaking out along the extra dimensions and being diluted in the process. None of the other forces can make the crossing. Dr. de Rham likens living on a brane to living on the surface of a body of water, which we can easily see, while a vast ocean beneath remains undetected.

Now, if gravitons can wander from one brane to another, are other dimensions, other universes, detectable? Dr. de Rham points out that, in principle, it is possible to discover other dimensions. But, keeping in mind that not all braneworld cosmologies invoke multiple branes, finding one with another universe would be much more problematic. The graviton effect would be subtle since we have not yet detected other dimensions or branes. Of course, Dr. de Rham finds the possibility of such detection very exciting!

What might such observations be? Dr. de Rham says we start by asking, "What would be different if we lived on a brane?" Well, it turns out that Newton's laws would be different — at least on scales that have so far gone untested. For example, no one has looked at the gravitational force over distances of less than a micron, and for good reason. The required measurement accuracy is of such a high order that the experiment has been rendered impractical, at least for now. While testing gravity over various distances is the best way to check the theory, further investigations could be done by closely scrutinizing the expansion of the Universe or understanding the nature of dark matter and dark energy. One could also look for clues in the cosmic background radiation in ways similar to what has been done by the *Cosmic Background Explorer* satellite (COBE) and the *Wilkinson Microwave Anisotropy Probe* (WMAP), or will be attempted by the upcoming *Planck* mission. The goals of the latter include determining the geometry, contents, origin, and evolution of the Universe. Observations of the microwave background will be made with unprecedented accuracy and detail. At the other end of the size spectrum, high-energy collisions in particle accelerators such as the Large Hadron Collider at CERN, Geneva, may potentially offer a window onto extra dimensions.

Why search for branes from Canada? Dr. de Rham finds this country an exciting place to do science — a friendly, dynamic country affording lots of opportunity. And so, with such bright prospects, we can rest assured that, in the case of at least one scientist, there is not likely to be a "brane drain."

Philip Mozel is a past librarian of the Society and was the Producer/Educator at the former McLaughlin Planetarium. He is currently an educator at the Ontario Science Centre.

Pen & Pixel

Kevin Black of the Winnipeg Centre captured the Andromeda Galaxy and an errant Perseid meteor in this lop-sided image from the night of August 12. He used a Canon 20Da, a 15-mm f/5 lens, and an ISO setting of 400 for this 2-minute exposure. The camera was riding on a Byers CanTrak.