PEOPLE

Does metaphysics have a role in physics?

To cite this article: David Richardson 2016 *Phys. Educ.* **51** 056001

Phys. Educ. **51** (2016) 056001 (3pp)

Featuring relationships, personalities, interactions, environments and reputations involved in physics and education

INTERVIEW

Does metaphysics have a role in physics?

'HowTheLightGetsIn2016' is a philosophy and music festival at Hay-on-Wye. Physicists from across the globe come to discuss and debate topical ideas, often at the edge of present understanding. David Richardson met up with Professor Bernard Carr after he had debated multiverse theory. He is Professor of Mathematics and Astronomy at Queen Mary University of London (QMUL).

What got you interested in physics right at the beginning?

When I was at school I studied maths and physics and remember reading the book 'The ABC of Relativity' by Bertrand Russell. I was about 15 and it got me fascinated in the question of the nature of space and time. When I went to Cambridge, I read mathematics rather than physics but I focussed on applied maths rather than pure maths and this led me to study topics like fluid dynamics, relativity theory, cosmology, electromagnetism, quantum theory and particle physics, which might be classed as mathematical physics.

Did you always think you would be interested in cosmology?

I was always interested in cosmology but my decision to do research in this area was the result of the progressive specialisation entailed in my university education. The final step was when I had to choose whether to do a PhD in cosmology or particle physics. I chose the first and was lucky enough to have Stephen Hawking as my supervisor. But I've always maintained my broader interests in maths and physics. Actually I'm never quite sure whether I'm a mathematician or physicist. Officially I'm a Professor of Mathematics and Astronomy and for most of my professional life I've worked in the Astronomy Unit in the School of Mathematical Sciences at QMUL. But a few years ago the Astronomy Unit moved to the Physics Department, so I suppose that I'm now a physicist.

In the debate I've just listened to you said that you're paid to think. What does a day in the life of a theoretical physicist look like?

I said that somewhat tongue in cheek because I love thinking and would probably do it even if I wasn't paid for it. It's true that I'm paid partly to think and I have to produce enough thoughts (i.e. papers) to justify my research grants. However, like all academics, my job involves a combination of research, teaching and administration, so I'm only partly paid to think. Indeed, nowadays academics spend ever increasing amounts of time on teaching and admin, so the time for research is much less than it was when I began my career 40 years ago.

What do you find yourself thinking about most at the moment?

My main areas of research are relativity, cosmology and astrophysics but I'm also very interested in particle physics. Indeed, one can no longer regard cosmology and particle physics as separate fields, since they naturally merge at the big bang. This is because, when one looks out to the largest distances, one is also looking back in time to when the Universe was very hot and compressed.

To answer your question more specifically, I have a particular interest in black holes and especially the 'primordial' ones which may have formed in the early universe. Although there is plenty of evidence for stellar black holes (which form at the endpoint of evolution of sufficiently massive stars) and supermassive black holes (which reside in galactic nuclei and power quasars), we don't know for sure that primordial black holes ever formed. However, they're very

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interesting because they're the only ones which are small enough for Hawking radiation to be important.

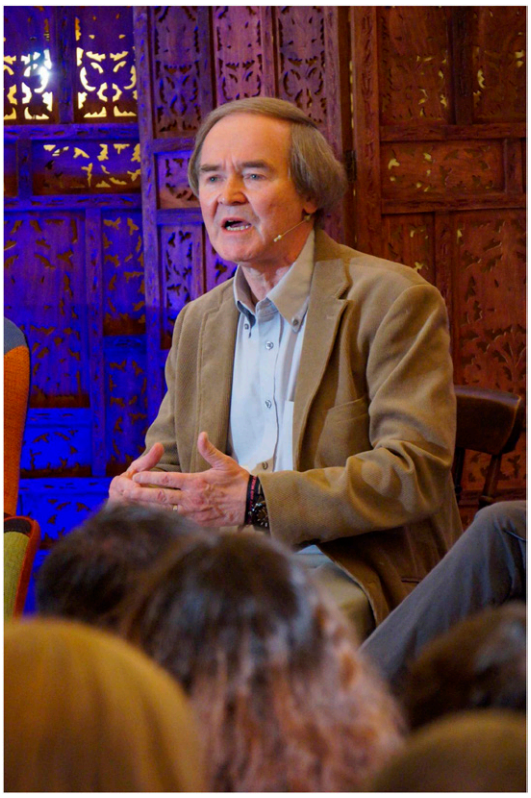
So I guess it is possible that what you think about might turn out not to be true?

It's certainly possible that primordial black holes never existed, even though I've spent 40 years thinking about them. I've also spent a lot of time thinking about the anthropic fine-tunings and the multiverse proposal (which may provide the best explanation of these tunings). It's possible that other universes don't exist either, so I suppose it's true that I spend a lot of time contemplating things which might not exist. But that is always a risk at the frontiers of physics because the ideas proposed are inevitably speculative. Many of them may turn out to be wrong but one might not find out for 50 years.

In any case, the study of a topic may be useful even if it turns out to be wrong or not realized in practice. The prediction of Hawking radiation—one of the most important developments in physics of the last 50 years—is a striking example of this. Hawking would not have discovered this if he had not been studying primordial black holes, so it has been useful to think about these objects even if they never formed. I'm sure the same applies in other areas of theoretical physics. The path to truth can be just as important as the final destination.

I've heard the phrase metaphysics used a few times today. Do you think that's an important area of physics?

Historically, the boundary of physics on both the largest or smallest scale has always represented an interface with metaphysics. This is because at the frontier of physics one may not have the relevant empirical evidence to test an idea. Occasionally the discovery comes first but usually there's a lag between the theory and the confirming observations. So there's a grey area between physics and metaphysics and the progress of physics entails a steady shift in the boundary between them. Sometimes physicists use the phrase 'metaphysics' in a disparaging way but I don't think of it like that. After all, science itself emerged from natural philosophy. What is interesting about the present situation is that the macro and micro physics/metaphysics boundaries have met at the



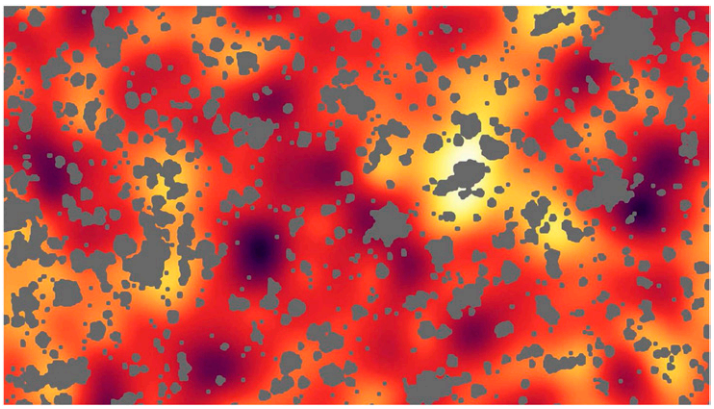
Bernard Carr at 'HowTheLightGetsIn 2016', Hay-On-Wye. (Credit: Gary Williams).

big bang. So this raises the issue of whether the domain of physics has reached its final limit.

When you're interacting with your colleagues do you ever have arguments?

I don't much like the word argument because it sounds too personal but certainly skepticism and disagreement is fundamental to physics. On any frontline issue, there will inevitably be a variety of views and sometimes completely opposite views. For example, I work on the multiverse but some people say, 'Not only do I not believe in the multiverse but I don't believe it's actually science at all'. My own view is that other universes may well exist but it's unclear whether enough evidence will ever be forthcoming for this idea to qualify as science.

In fact, everything in physics is controversial at first and there's always scope for disagreement until relevant observational evidence has been obtained. Once it has been, the disagreement goes away but then there is disagreement about something else. For example, the existence of



The cosmic infrared background (CIB)—possibly featuring primordial black holes. (Credit: NASA/JPL-Caltech/ A Kashlinsky (Goddard)).

black holes was at first controversial, with neither Einstein nor Eddington believing in them, and it was 50 years before the evidence became incontrovertible. Now people argue about whether the black holes are rotating and how they are accreting.

What you're talking about is an amazing journey of physics. If you could say something to a young physicist, what would you say to them at the beginning of their journey now?

If it was a young person, I would say that you have to toe the party line if you want to pursue a career, because mainstream physics is what gets funded and what will gain you a PhD and a job. But the most exciting issues to my mind are those which go beyond the mainstream, because that's where the new paradigms are likely to emerge. Theories of the multiverse, quantum gravity, extra dimensions etc. are inevitably regarded with skepticism initially—and such ideas might also be regarded as lying on the border of physics and metaphysics by some people—but they may turn out to be more important in the long run. Young people probably shouldn't work in these areas if you want to get a job. On the other hand, young people are inevitably interested in these areas and are most likely to produce the new paradigms.