Profile: Michael Merrifield

Michael Merrifield, Professor of Astronomy at the University of Nottingham, discusses his work on astrophysical dynamics, the state of astronomy in the UK and why he stopped boycotting the RAS.

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Back to the UK
After CITA, I really wanted to come back to the UK. My parents were getting older, and I had finally figured out that I should have married the girlfriend I left behind, so there were lots of good reasons to return. Happily, I was able to get a job working for Ian McHardy in Southampton. Again, it was in a rather different area, studying active galaxies, and analysing X-ray and radio data, but it was an exciting challenge to learn something different, and hopefully contribute something by adding my understanding of the host galaxies to Ian’s expertise in the properties of their active nuclei. I also taught the invaluable skill of writing convincing applications for telescope time, which has also stood me in good stead ever since. As I came to the end of the postdoc, I was seriously considering leaving astronomy, because although I loved the science I was getting too old for the associated peripatetic existence. Happily, though, I was able to win a PPARC Advanced Fellowship, which allowed me to continue enjoying astronomy at Southampton, but once again running my own research programme.

I was three or four years into the fellowship when Nottingham advertised for someone to head the new astronomy group they were setting up.

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Although I had a telescope when I was a child, I grew up in London and the sky was never that impressive. It wasn’t really until I was in the final year of my undergraduate physics degree at Oxford that I chanced on astronomy. To be honest, it looked easier to tackle a subject that we had not done before rather than something with a title like “advanced solid-state physics”, but once I started I was hooked. I was also never that keen on laboratory work, so was drawn to astronomy because it is not an experimental science – instead you have to work with what you’ve got: you can’t pick up a galaxy and turn it round, to see what it looks like from another angle. It’s funny really because my father was an archaeologist, and like many teenagers I did my best to avoid following in his footsteps, but I have ended up in a subject remarkably like archaeology, as we also try to use the fragmentary evidence available to us to reconstruct the history of astronomical objects.

Galaxy distribution
For my PhD at Harvard, I worked with Steve Kent on a project looking at the distribution of galaxies within clusters. There were secondary nuclei found embedded in the bright galaxies that often reside at the centres of clusters, but in the 1980s we didn’t have the data to tell if these were signs of galaxies merging or merely coincidental line-of-sight projections of unrelated systems. My research involved making quantitative estimates of how many were likely to be chance projections, and also measuring their relative velocities from spectra, to see if they were travelling slowly enough to be likely to be merging. This work introduced me to the idea of viewing astronomical systems as fundamentally dynamical, and most of the research I have done since has been looking at the motions of objects within astronomical systems, whether they be galaxies in clusters or stars in individual galaxies, to try to unravel their evolution.

Harvard was a fascinating place to be, scientifically, socially and culturally. The Center for Astrophysics is now enormous, but even in the 1980s there were more than 250 PhD astronomers working there, creating an exciting buzz. As an undergraduate I was not really plugged into the academic side of life, so this was my first exposure to a research environment. The system there was for postgraduate students to spend their first year on course work, and to hook up with a supervisor in the second year. Because Harvard does not take on many students each year – there were six in my year – they are much in demand, with lots of exciting PhD projects to choose from. I ended up working with Steve Kent partly by chance, and partly because of my own bloody-mindedness. In one of his postgraduate lectures he mentioned that some result in stellar dynamics could not be demonstrated, and I went home that evening, played with the maths, and stumbled across a proof, which I pushed under his door the following day. I guess he figured that if I was foolish enough to work all night on that, I might be worth talking to. I ended up doing the galaxy cluster project and learning a huge amount from him, for which I remain very grateful.

After my PhD I went to a postdoc at the Canadian Institute for Theoretical Astrophysics (CITA). When you arrive there, they give you a desk and a computer and leave you to do something interesting – effectively they push you off the ledge and see if you fly! In retrospect, I can see that there were all sorts of safety nets to ensure that you didn’t crash and burn, but at the time it was quite scary. I carried on with the same sort of dynamical work I had been doing, but applied it to individual galaxies and our own Milky Way, rather than whole clusters. This change of focus was something that the freedom of a CITA fellowship allowed, and I think is something we lack in the UK, particularly with the demise of the STFC Postdoctoral Fellowships. In this country, PhD students get locked straight into a research project, and then tend to stay in that field. They do not acquire a broad training, and by the time that they are given the freedom to define their own research through fellowships, they are strongly committed to the field in which they began. I am sure that we miss out on lots of exciting research opportunities because much new science lies at the interfaces between subjects, but unless we encourage people to acquire expertise in several areas they will never have the tools to explore these interfaces.

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up. It was an exciting opportunity and, despite what I remember as one of the worst job application talks I’ve ever given, I was offered a job. Originally they had planned to appoint a chair and two lectureships, but they could not decide between me and Peter Coles and so the Vice Chancellor waved his magic wand and created professorships for both of us. We got to set up an entirely new group, with no baggage and no historic interests to accommodate, so it was a very exciting time. We had a lot of fun making a set of appointments that worked really well, giving our new group a range of interests that overlapped without duplication, creating lots of interactions at those all-important interfaces. The group has now grown to some 40 people, and happily continues to thrive in the exciting field of galaxy formation and evolution.

My main research project at the moment involves using planetary nebulae (PNe) as probes of galaxy dynamics. PNe are just ordinary stars at the ends of their lives, so are pretty much representative of the stellar population, but conveniently give out almost all their light in a single emission line, so the Doppler shift arising from their line-of-sight velocities is readily observable. A group of us from the UK, the Netherlands, Italy and Australia designed and built an instrument, the Planetary Nebula Spectrograph, which finds these objects and measures their velocities all in a single shot. The spectrograph is very simple with few moving parts, so we were able to put the whole thing together on a relatively shoestring budget of around £100k. With it, we can measure the stellar kinematics of the faint outer parts of galaxies using the 4.2 m William Herschel Telescope, which would not be possible using a conventional spectrograph on even a 10 m telescope. It’s the kind of project I really enjoy, as we have been able to see the whole thing through from doodling designs on the back of a beer mat through building and commissioning to publishing unexpected and exciting results in Science and MNRAS.

I think losing the ability to do this kind of cheap-and-cheerful science is one of the risks we face in the move towards ever larger telescopes and bigger consortia of researchers. The setup at the European Southern Observatory, for example, while superb at what it does, doesn’t easily accommodate the kind of hands-on sandbox approach that developing this spectrograph required. As instrumentation projects get bigger, the number of people involved becomes larger and the timescales to completion become longer, so it is hard for more junior scientists to take ownership of a whole project and see it through from preliminary design to final science. Training the next generation of project leaders becomes much harder in such an environment.

By shutting down medium-scale facilities, or at least losing general access to them for UK scientists, we are missing scientific opportunities and we are losing the sort of “playing around” time that lets you try out apparently crazy ideas. Just look at all the exciting exoplanet work that’s going on now. That was something that came out of people finding clever ways to work on relatively small telescopes, and that pioneering work has now spawned an entire field, with equally fascinating exoplanet observations now being made on the world’s largest telescopes. But if it hadn’t gone through that stage of risky innovation and getting techniques to work on medium-scale instruments, it would never have happened, and we would probably still be ignorant of the very existence of planets around other stars.

Bigger science

Ground-based astronomy seems to be following in the footsteps of space-based astronomy by moving towards very large telescopes, and very large and expensive instruments. And, of course, because each of these costs more, there are fewer of them. I think the prospect of astronomy being dominated by the sort of project where you don’t get to see the data until you’ve retired would put a lot of good people off – it wouldn’t have inspired me! When I was an undergraduate, this was already the way experimental particle physics worked, and I knew that I did not want to be buried in a huge project, working on papers with hundreds of authors. Astronomy appealed precisely because you can have an idea, think it through, make the observations, understand the results and write the papers, as an individual or in a small group: you see the whole process through.

I guess I would argue that we need to look forward to direct measurements of the accelerating expansion of the universe, or the detection of biomarkers in exoplanets’ atmospheres. But in the intervening decades, we need continued access to smaller-scale less-regulated facilities to try out new ideas and make sure that astronomy continues to inspire the upcoming generation with projects they can lead and see through from beginning to end.

Generally speaking, though, I am reasonably optimistic about the current state of UK astronomy. Things were bleak when STFC was created, with a lot of very predictable bad things occurring as a consequence, and at the time we lacked effective professional representation through the RAS, which unfortunately failed to press for measures to mitigate the predictable fallout. Subsequently, though, STFC has found its feet and evolved towards a structure that is supportive of the kind of science that we want to do. The walls introduced between budgets certainly help protect us against the rising costs of running facilities and international subscriptions, albeit at an uncomfortably low level due to the damage already done. Similarly, the current president of the RAS and his predecessor have really upped the ante in terms of effective lobbying and working with STFC. I had long resisted joining the RAS, put off by the “gentleman’s club” atmosphere of the place – the tone was set when I first came back to work in the UK and overheard a fellow referring to the National Astronomy Meeting as the “Out of Town meeting”. I could not help but contrast it to the high-quality professionalism that I had encountered in the American Astronomical Society. Just last year, I realized that almost all of the issues I had had with the RAS had been sorted out, and decided it would be simply churlish to continue refusing to join. Rather surprisingly, I was able to find two Fellows to nominate me despite the rude things I have said over the years about the RAS, and I am now a Fellow myself.

Looking to the future, I hope to continue working away at the interfaces, developing ideas where disciplines overlap. I also love the opportunities that astronomy presents to learn about entirely new fields. Just a couple of years ago, for example, I was drawn into analysing the way in which we allocate time on telescopes, and became fascinated by electoral theory and whether it can be applied to peer review (A&G 50 4.16–4.20), which has got me involved in several studies of how we allocate resources. My hope is that even in the era where the nature of big science means that many projects require large prescriptive collaborations, there will still be room for this kind of play and the different flavour of science that it produces.