Growing pains

Leslie Sage and Joanne Baker

Astronomy is becoming 'big science'. Although the transformation brings the experimental clout to answer the biggest questions, it also carries risks for the field's future.

Astronomy is in an era of unprecedented change. Once the preserve of a dedicated few who travelled to remote observatories to investigate the heavens, the discipline is now 'big science', carried out on an industrial scale by a workforce of postdocs. Just as bankers have been seduced by the sophistication of computer analyses, more and more astronomy papers are showing evidence that familiarity with the essential 'dirtiness' of data and models is being lost.

Overly confident with their polished results, researchers are tempted to cut corners. In competitive fields, such as searches for high-redshift galaxies, it is now common for papers to be presented for publication without showing the actual data on which the conclusions are based; error bars are often omitted. As journal editors who follow manuscript submissions, we are concerned that this indicates that astronomers are less inclined to consider the limitations of their data in an era of huge databases and automated reduction procedures. This remoteness is only set to increase — more and more students have never been to an observatory, let alone fought cranky equipment and poor weather. Theorists who use other people's code run the same risk — they are not aware of the limitations and assumptions under which it was written.

Worries that the centuries-old culture of astronomy is being eroded have been voiced in the community for several years, especially in cosmology where the big-science approach now dominates. But so far these comments have largely been ignored or interpreted as partisan. In 2007, Simon White, a director of the Max Planck Institute for Astrophysics, cautioned that in chasing fashionable goals such as dark energy with everything we have, we may neglect equally vibrant but more scientifically fertile areas such as galaxy evolution. He was right, but his plea fell on deaf ears because it was interpreted narrowly as criticism of a particular space mission.

Jim Gunn, a professor of astronomy at Princeton University and winner of a US National Medal of Science in 2008, has also worried that the big-science push will reduce innovation. Addressing the American Astronomical Society in 2006, he highlighted the need to consciously design into large projects some room for serendipitous discoveries. Even the biggest galaxy surveys might offer little in the way of new insights, he cautioned, unless they are recorded in ways that leave them open to wide-ranging inquiry later. Otherwise we risk investing our scarce resources to gain little more than reduced error bars on something we already knew.

In an era of big science, where will the maverick views come from that will break new scientific ground? Astronomers have long researched independently. By harnessing the competitive drive and curiosity of individuals and small teams, astronomical discoveries have multiplied in the last fifty years, from the cosmic microwave background to black holes and pulsars. Now we routinely see papers authored by over 200 people, happy to sign off that "All authors contributed significantly to the work reported here". Such large collaborations distance researchers from the coal face of science and are dishonest in accrediting work. Postdocs and students fare worst, because it is hard to shine in such a crowd, and permanent jobs may escape the best, being awarded to those who have someone senior to lobby for them.

There are positive aspects to the growth in collaboration. Costly new telescopes become feasible and more people have access to more data. There is a gratifying trend towards multiwavelength studies, which require team members with expertise in the different fields. But collaborations involving hundreds of people are notoriously difficult to run. Formal memoranda of understanding between institutions that specify in excruciating detail how every communication is handled — down to the idiocy of gamma-ray-burst alerts having to go to a publications committee before being issued — are inimical to the free-wheeling world of astronomy. In private, many astronomers say that they regret being part of large collaborations because the rules don't work for them.

There are solutions. The training of young astronomers should be seen as a greater priority; it is too common that they are used as data slaves and then cast adrift. Students need to understand how an instrument works, how data are collected and reduced,

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Action at a distance: astronomers risk becoming too remote from their own data.

and they need to see that the effort they expend will be rewarded by recognition. They could be taught professional skills, such as how collaborations work in real life and how to manage projects, by looking at past examples. Astronomy's long history includes many stories of success and failure in team-working. And being pragmatic, graduate schools should accept that more than half of their students will forge careers beyond academia and broaden the base of experience to better prepare students for alternative careers.

As journal editors, we can encourage people to write better papers and not aim only for the preprint timestamp to beat a competitor. We can exhort that more care be given to considering the quality of a person's work, not just its quantity or whether it made a big splash, for right or wrong reasons. But it falls to the community itself to create its own culture.

In moving to big science, astronomy is adopting practices that go against decades of experience in how to keep our science innovative. The alarm has been sounded, but few are listening because the crisis is not yet upon us. It will come a generation from now, but it is coming. ❐

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