Science in the shadow of a pandemic

We are living in exceptional circumstances. It is not business as usual. There is no script, and where we end up after the global pandemic is partly up to us.

In late 2019, cases of deadly viral pneumonia began emerging in Wuhan, China. By 1 May, the new respiratory illness, COVID-19, had infected at least 3.3 million people and killed more than 234,000 in 210 countries and territories. One by one, heads of state announced varying measures to stem the spread of infection — to 'flatten the curve' — from telling people to wash their hands and/or practice social distancing to enforcing full lockdowns. Until there is an effective vaccine, or a reliable and scalable way to test the population for antibodies, it remains unclear how long such measures will last and to which degree; many countries are planning a gradual return to normality that could span several months.

Initially, it looked as though many astronomers could easily continue with their research from home, as the community is used to working with just a computer and an internet connection. Plus many astronomers working in large collaborations are already used to conducting group meetings online and analysing data from almost anywhere. However, when huge swathes of the population suddenly all work from home, a whole set of unexpected problems arise: simultaneous childcare, online teaching, internet security ('Zoom bombing') and mental health issues.

With up to 90% of the world's students in lockdown, their education is greatly impacted, as are their parents' abilities to work. Even with children remote-learning at home, they need a lot of attention throughout the day. And what about younger children? Some companies allow their employees to take unpaid leave or be furloughed with (part) pay, and early data show that in such times, the age-old gender biases return, worsening the already poor state of gender inequality. As a concrete example, women submitted 50% fewer astrophysics papers on arXiv.org compared to the same January–April period a year ago.

As for teaching online, it is new for most teachers and lecturers, so there is much additional work in terms of getting to grips with technology, preparing lessons and assessing progress. It remains to be seen how assessments can replace exams for this year's cohort. And is going online the answer for everything? What about public education, outreach, conferences and all the other things that have been cancelled or delayed indefinitely?

The International Astronomical Union (IAU) has taken up the challenge, advising conference organizers to find creative solutions to bring their meetings online if possible, and to use this opportunity "to inspire innovative approaches that may even be adopted in the future, under normal circumstances". It will be interesting to see how the virtual American Astronomical Society summer meeting 1–3 June will go. Without the need to travel, it will certainly increase access for those with family commitments, mobility issues, travel difficulties and so forth. On the flip side, younger academics will miss out on the networking opportunities and chance meetings that can help their careers. If we do find solutions that are not mere temporary replacements for how things used to be, but even better and more inclusive, we will be returning to 'normal life' with a more resilient way of working.

And to keep promoting astronomy, the IAU has further put out a call to action "to do whatever we can to help tackle this pandemic as well as its collateral effects on society". To help educate and entertain those fortunate enough to have internet access, the IAU website hosts a growing list of digital resources from around the world. There is even a section for 3–5 year olds, provided by the Royal Astronomical Society. The IAU website also has links to hands-on activities, webinars, virtual tours, free textbooks, online courses and competitions for all ages, and citizen science projects. Many of the listings come in different languages.

With regard to observational astronomy, safeguarding personnel has meant that operations had to be scaled back or even closed, with minimal on-site staff. At ESA, for instance, Solar Orbiter, the Cluster quartet, ExoMars Trace Gas Orbiter and Mars Express went into hibernation when a team member tested positive for COVID-19, but the missions have since come out of safe mode. Meanwhile, BepiColombo (ESA/JAXA) remained active and made its single flyby of Earth on 10 April en route to Mercury.

NASA has suspended work on the Orion spacecraft and Space Launch System heavy-lift rocket for the Artemis 1 launch. However, three astronauts (two NASA, one Roscosmos) returned safely from the International Space Station on 17 April, having left a different Earth on 6 February. Many ongoing missions are operating with mostly at-home staff, such as the Hubble Space Telescope (which just turned 30), OSIRIS-REx (which got within 75 m above the surface of Bennu on 14 April in a practice landing) and the Transiting Exoplanet Survey Satellite (TESS), to name but a few.

As for ground-based facilities, the Maunakea observatories are closed, as are the Atacama Large Millimeter/submillimeter Array (ALMA) and ESO's other observatories. LIGO/Virgo cut short their third observing run by one month, and the Event Horizon Telescope missed its 2020 observation window in late March/early April, having planned to add three more telescopes to its network this year.

With space, robotic and some other telescopes (including the Australian ones) still running, proposals in the works and a trove of archival data, there is plenty of work to do. But we also need to look after our mental health. The psychological effects for people under quarantine (from past SARS, Ebola, H1N1, MERS epidemics) are well-known (Samantha K. Brooks et al., *The Lancet* **395**, 912–920; 2020); these range from low mood, anger and depression to post-traumatic stress symptoms (anxiety, insomnia, poor concentration). It is particularly difficult that there is much we don't know about the virus, so we can't know how long the lockdown, or some form of physical distancing, will last. Aside from staying informed, we should take the time now to take care of ourselves, even if it means reducing our productivity, publishing fewer papers or writing fewer proposals. When we spend so much of our day sitting (in many cases on unsuitable chairs) in front of a computer, it is important to switch off, be mindful, connect with our friends, maybe look up at the night sky. ❐

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