Editorial

https://doi.org/10.1038/s41550-024-02193-z

Focus on astrobiology

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A series of pieces published in this issue highlights the breadth and depth of topics discussed in modern astrobiology, an exciting discipline that has come to the forefront of astronomy in recent years and promises to answer one of the most fundamental questions of humanity.

Introduced by a beautiful drawing by James Tuttle Keane on the cover, this issue of *Nature Astronomy* hosts a series of papers centred around astrobiology. You can find the whole collection in a dedicated website together with pieces that we published on the field in recent years. The set showcases a wide but far from exhaustive spread of topics that are focusing the debate and the effort of researchers in modern astrobiology, particularly from an astronomy point of view.

One of the most pressing questions the community is currently tackling is how to identify, and to which level of confidence, environments that have the potential to be habitable – or even inhabited. The quest to define the 'best' biosignatures for such a purpose is intense, and it is entangled with our present and future capability of actually detecting them. The Article by Amber Young and colleagues and the Perspective by Amaury Triaud, Julien de Wit and co-authors are perfect examples, as they propose promising diagnostics (chemical disequilibrium and low atmospheric carbon abundance respectively) and discuss their detectability potential in exoplanets using JWST and upcoming telescopes. Triaud, de Wit et al. even trace an observational roadmap for transiting planets. The Perspective by Charles Cockell and co-authors, on the other hand, reminds us that, if instantaneous habitability is probably a common occurrence, what we are really interested in is a prolonged one – not only because it is the place where life can actually have the time to develop, but also because it gives us a longer baseline during which to detect it. An important point raised by Cockell et al. is the use of our Solar System, easier to reach and characterize than distant exoplanets, to assess habitability in different environments with a comparative geological approach. Such searches would however involve the analysis of a massive amount of data, and Caleb Scharf and colleagues in their Comment remark on the important supporting role Artificial Intelligence (AI) could play. AI has the potential of being transformative in astronomy as in many other fields, and various groups are already exploring applications in astrobiology.

A subset of biosignature studies concerns one of the most exciting – and, for some people, unsettling – aspects of space exploration: technosignatures, indicators of technologically advanced civilizations. The Perspective of Amedeo Balbi and Adam Frank introduces a rarely considered point of view: without trying to pinpoint the nature of the most useful technosignature, the authors suggest that the environment itself provides a clue with the existence of an 18% threshold for oxygen abundance, below which the difficulty to initiate combustion would make it hard to develop technology. Astrobiology is indeed a field where pure research goes hand in hand with 'big concept' philosophical discussions. Two examples in our Focus issue are the Perspective from Ian Crawford and Dirk Schulze-Makuch on why the idea that advanced civilizations exist but are hiding from us (the so-called 'zoo hypothesis') is the only explanation for the lack of technosignature detection (the 'Fermi paradox') and the Comment by Cyrille Jeancolas et al. on astrobiology as a serious science. The latter, which raises a question surely several astrobiologists have heard in whispers here and there, also showcases the truly multidisciplinary nature of astrobiology that connects, in addition to the physical and life sciences, the social sciences too. The EURiCA project (Exploring Uncertainties and Risk in Contemporary Astrobiology) from the Centre of Humanities at Durham University is just an example of current attempts to cover such a complex field from all the necessary perspectives.

Inevitably, a field that tries to answer one of the main fundamental questions of humanity ('are we alone?') attracts the attention of media and public alike. There is always the risk that the way the information is conveyed is overhyped or misleading, leading to disaffection or distrust. As a publisher, we have always been interested in the correct communication of scientific results: already in our second issue, in faraway February 2017, we published two Comments and a related Editorial on the topic. Since then, the community has been very active in discussing this thorny issue and trying to find solutions. Some time ago, we published a Correspondence by Adrian Lenardic and co-authors wondering whether a rigorous numerical scale for communicating astrobiological results, published in *Nature* by James Green et al., is indeed the best path forward. In this issue, Green and colleagues reply in another Correspondence, highlighting the progress that has been made since their previous publication. We are glad to participate actively in this effort, which involves a lot of back-and-forth debate.

It is pretty clear that astrobiology, for a long time dominated by the 'bio' part of the equation with the study of extreme environments and organisms, is here to stay in the astronomical field, bolstered in recent years by exoplanetary and Solar System discoveries. The last US Decadal Survey on planetary science added "and Astrobiology" in the title for the first time, and the top priority of the analogous survey for astrophysics was a large IR/O/UV space telescope that coalesced on a Habitable Worlds Observatory (HWO) proposal, with clear astrobiological implications.

At *Nature Astronomy*, we have always considered astrobiology as being fully within our scope. The role that we aim to play in this multifaceted and multidisciplinary field is twofold, as well exemplified by this collection. From one side, we want to publish cutting-edge astrobiological discoveries and state-of-the-art methodologies, especially those that have an astronomy-oriented focus and approach. From the other, we want to continue to foster the dialogue within the community and showcase the most interesting conceptual, and sometimes controversial, ideas around astrobiology. As we can host both original research and comments and opinions in our pages, we are naturally flexible and suited for such a purpose. In addition, the synergy we have with other journals of the Nature Portfolio places us in a unique position to tackle the multidisciplinary challenges brought forward by the discipline. Astrobiology's bright years are ahead, and we are looking forward to seeing what the future holds!

Published online: 22 January 2024