

Ricky's Afterthought:

Are we alone in the Universe? The Search for an Earth-like Exoplanet

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Early Research

"I have done something wrong" was the repeated mutterings of Didier Queloz a PhD student working at the Observatoire de Haute-Provence in France in 1994 where a special machine was built to his specification for detecting the variations of light from distant objects in our Galaxy. He was working away from his base at the University of Geneva as his supervisor Dr Mayer was on sabbatical at the University of Hawaii. The detector, a new fibre-fed spectrograph termed ELODIE, was observing light emitted from 51 Pegasi, a star in the Pegasus constellation about 50 light years away from Earth. What was puzzling was that the light was not constant and, what is more, every observation was different as though something big was getting in the way of the light being detected. The instrument permitted measurements of radial velocity with an accuracy of 13 msec^{-1} of stars up to 9 mag (designating the brightness of stars) with an exposure time of <30 mins. Was it possibly an exoplanet, that is, a planet outside our solar system orbiting its companion star and interfering with the light detected in his spectrograph? "No it cannot be" reflected young Didier because researchers had looked for exoplanets since the 1950's and none were found.

He decided to pursue and examine the data further and was convinced that his machine was performing as planned and there was nothing wrong with its design. So after checking and checking again the results, he contacted his supervisor and tentatively suggested that he may have found the first exoplanet, a giant gaseous object orbiting its companion star just over 4 days and being about 8

million km away. (Note for comparison the Earth rotates around the sun every 365.25 days).

When his supervisor returned they checked the data many more times and finally convinced themselves that there was evidence that this was indeed an exoplanet. They presented their results in a meeting in Florence which stunned the astrophysicists attending the meeting and promptly sent a paper to NATURE which was eventually published in the fall in 1995 [1]. Within a short time after the announcement of this discovery, independent observations of the 4.2 day period radial velocity variation was obtained at the Lick Observatory as well as by a joint team at the High Altitude Observatory and the Harvard Smithsonian Centre for Astrophysics.

Was this Jupiter like object orbiting around 51 Pegasi anything like our earth? Obviously not as its temperature was about 1000°C so could not sustain life as we know it. Since this discovery Didier Queloz, now Professor at the Cavendish Lab in Cambridge, discovered many more exoplanets and overall researchers found some 1900 of them in various parts of our galaxy. What is interesting is that most of these planets are very diverse, gas massive super Jupiters, mini Neptunes and other forms.

Nobel Prize and the Cambridge Exoplanet Research Centre

Prof. Queloz, together with his supervisor Michael Mayer and colleague James Peebles, won the 2019 Nobel prize for Physics and is directing a programme at the Cambridge Exoplanet Research Centre to find the equivalent of solar systems using the findings of the European Space Agency's Plato Project, a Space based observatory for searching for planets and due

to be launched in a couple of years. But first Prof. Queloz hopes to have a better opportunity in detecting an earth-like exoplanet using Nasa's James Webb Space Telescope (JWST) which was successfully launched a few months ago.

The JWST is a joint effort with Nasa and Europe's and Canada's Space Agencies. A most complicated task for Nasa's space scientists was the unfolding and stretching out its huge sunshield which was accomplished early this year. Aligning the telescope's 18 primary mirrors will take months to complete. Finally, a mid-course correction burn will be initiated to place the telescope around its final orbit about 1 million miles from earth. Professor Andy Parker Head of the Cavendish Laboratory suggests that there are potentially billions of exoplanets that may be habitable and could take us closer to answering the fundamental question as to whether we are alone in the Universe.

Statement by Lord Rees

Professor Lord Martin Rees, Astronomer Royal and Emeritus Professor of Cosmology and Astrophysics at the University of Cambridge stated:

"Jim Peebles played a key role back in 1965 in appreciating and interpreting the 'cosmic microwave background' radiation – the 'afterglow of creation' [2]. He has been the most influential and respected leader of empirical cosmology with a sustained record of achievement spanning half a century. The study of exoplanets is perhaps the most vibrant field of astronomy. We now know that most stars are orbited by retinues of planets; there may be a billion planets in our galaxy resembling the Earth (similar in size and at a distance from their parent star where liquid water can exist). This takes us a step towards the fascinating question of detecting evidence for life on the nearest of these exoplanets. Queloz and Mayor not only discovered the first planet orbiting an ordinary star, they are also among the leaders in the ongoing research that has led to the discovery of many thousands of other planetary systems, exhibiting an unexpected variety. These awards seem to show, incidentally, a welcome broadening of the Nobel criteria. In the past, astronomy has been included primarily when the discovery involves some new physics (neutron stars, gravitational waves, vacuum energy, etc). But this award

highlights astronomy as among the grandest of the environmental sciences. And the award to Peebles will be welcomed by his friends and colleagues as recognition of a lifetime of sustained contributions and insights by an acknowledged intellectual leader, rather than a 'one off' achievement."

IPLU

The Leverhume Trust [3] has awarded a £10 million grant to establish a new research centre dedicated to exploring the nature and extent of life in the universe and to compliment the research carried out at the Cambridge Exoplanet Research Centre. The university has recently launched the Initiative for Planetary Science and Life in the Universe (IPLU) for cross disciplinary research on planetology.

The centre will include researchers from Cambridge's Cavendish Laboratory, Department of Earth Sciences, Yusuf Hamied Department of Chemistry, Department of Applied Mathematics and Theoretical Physics, Institute of Astronomy, Department of Zoology, Department of History and Philosophy of Science, Faculty of Divinity, and the MRC Laboratory of Molecular Biology. It will also collaborate with researchers at the University of Colorado Boulder (USA), University College London, ETH Zurich (Switzerland), Harvard University (USA) and the Centre of Theological Inquiry in Princeton, New Jersey (USA).

Professor Queloz comments: "The (IPLU) Centre will act as a catalyst for the development of our vision to understanding life in the universe through a long-term research programme that will be the driving force for international coordination of research and education."

For further reading

1. Michel Mayor & Didier Queloz, A Jupiter-mass companion to a solar-type star, *Nature*, **378**, 355–359 (1995). <https://doi.org/10.1038/378355a0>
2. AMPERE Newsletter, Issue 72, Afterthought article, March 2012.
3. The Leverhume Trust is a charity that provides funds for research and education. The original funds came after the death in 1925 of Lord Leverhume who bequeathed part of his holdings in his company Lever Brothers for specific trade charities. Five years after his death his company, whose main product was soap, joined forces with another company, Margarine Unie, to form Unilever.