Abstractions

FIRST AUTHOR

Designing a space telescope to detect Earth-like planets poses a number of technical challenges, most notably achieving contrast levels high enough to image a planet that appears 10 billion times fainter than the star it orbits. John Trauger, an astrophysicist at the Jet Propulsion Laboratory of the California Institute of Technology in Pasadena, and his colleagues have now reached those imaging limits in the laboratory using a coronagraphic instrument with a telescope that uses masks and a deformable mirror to suppress the star's glare (see page 771).

How does your model work?

If we can separate a planet's reflected light from that of its star we can not only detect that planet, but also analyse its spectrum to learn what is in its atmosphere. This process poses two main problems. One is the diffracted light caused by the edges of the telescope's primary mirror. Adding a Lyot-type coronagraph to the telescope is the simplest way to remove this. The other problem is fixing the irregularities in the light wavefront that come from flaws on the mirror's surface. Even tiny ripples will create a 'speckle' in the image that looks just like the signal from a planet. Because there are many randomly ordered errors on any mirror, the true signal is overwhelmed.

How do you resolve this problem?

We use a deformable mirror to correct aberrations to a really high accuracy, within one ten-thousandth of a wavelength. Such mirrors can change shape very precisely to perfectly correct for flaws in a primary mirror, making the number of speckles manageable.

How would your model scale up for use in space?

The apparatus is the same size as it would be in a flight instrument, about 1.5 by 2 metres. But in terms of accuracy it's not quite ready. It is a very simple system, with no more than six or seven mirrors between the star and the coronagraph mask. It could be launched with a telescope as one unit, and could be tested on the ground for performance. This contrasts with other systems that would require precise formations of several spacecrafts, which has never been done.

What do you think our chances are of finding Earth-like planets?

Our guess is that about 10% of the stars in our Galaxy probably have Earth-like planets. But we are only guessing. The only other planet systems we know of at present are unusual, with giant, Jupiter-sized planets orbiting a star every four days or so. How unusual is Earth and our system? It's a burning question. ■

MAKING THE PAPER

James Fowler

A computer game finds humans have a strong preference for equality.

There really is no such thing as a free ride — at least, not without reprisals, says a group of social scientists. James Fowler, an associate political-science professor at the University of California, San Diego, was intrigued by a paper published five years ago featuring a game that pitted people with different incomes against each other. In that game, each player had the option to spend his or her own money to make the whole group better off. Eventually, when each player had figured out the game's strategy, everyone became a 'free rider'. The rules were then altered, allowing people to punish free riders, who gained in wealth despite not contributing to the group. This caused the dynamics of the group to change. "Cooperation went up immediately, because people anticipated that they might be punished if they didn't contribute enough," says Fowler.

However, Fowler and his colleagues were unsure of people's motives for punishment. Was it that people wanted to punish free riders or that moderate-to-low earners resented the richer players? So they designed a new game. "We asked what experiment we could do to see whether people are motivated to take down the top guy," Fowler says. His team decided that the game should randomly assign incomes to each player and take away the option to contribute to the greater good, leaving only the options of punishing top earners and contributing to low earners — even though contributions would come out of each player's electronic 'pocket' and would not directly benefit them. "Overwhelmingly, people tended to bring down the top earner and bring up the bottom earner."

The researchers studied sets of 20 people playing at computer terminals. Participants were split at random into different groups of four at various stages during the experiment. Players had access to information about the incomes of others in their group, but couldn't see each other or each other's computer screens.

Setting up the game was far from easy for Fowler and his co-workers. It was the most complicated game they had ever designed, because they had to manage and monitor interactions between multiple subjects. In addition, they didn't have time to test it properly before the experiment. "We decided to get volunteers into the lab quickly, then had to throw out some data because of bugs in the program," Fowler says. Richard McElreath, who is based in the anthropology department at the University of California, Davis, where the game was played, tweaked the program, and the group was able to collect results from 100 people (see page 794).

Fowler suspects that the players' punishment of the rich stems from an evolutionary bent towards equality and cooperation. This has implications for society in terms of tax schemes or employment compensation. "You can encourage cooperation by making people more equal," he says. He notes that increased income disparity in the United States during the past 15 years might actually have increased resentment towards the wealthy and decreased cooperation overall. A more progressive tax scheme might ameliorate that.

To weigh participants' emotional responses beyond the keystroke data, the researchers conducted exit interviews, asking: "Would it make you angry if you ran into people who earned a lot more than you?" The response was an overwhelming "Yes". The players seemed to enjoy administering their own sense of social justice. "A lot of people asked if they could sign up again," Fowler says. Many more people will soon have that opportunity; McElreath is making the game available from his website. ■

KEY COLLABORATORS

Genome-wide analysis (GWA), the latest, highest-resolution genomic tool for studying the genetic roots of disease, requires collaboration among several fields. To analyse millions of datapoints, geneticists and clinicians must work with biostatisticians and bioinformaticians.

Such a team came together at the St Jude Children's Research Hospital in Memphis, Tennessee, to establish the roots of acute lymphoblastic leukaemia (ALL), the most common paediatric cancer.

Using patient samples from various studies done at St Jude, James Downing, chair of pathology at the hospital, and his team conducted GWA on 242 ALL-cell samples. They then compared 228 diagnostic bone-marrow samples from ALL patients with matched remission samples (see page 758). They reasoned that genomic differences found only in the former group represent somatic mutations that could contribute to pathogenesis.

They found that 40% of the ALL samples had abnormalities in genes that control B-cell development and differentiation. Downing thinks it might be possible to develop a small molecule to activate this pathway and trigger cell death in the leukaemic cells. "It's a different way of doing science," he says of the GWA studies. "It can be challenging and it can be great fun." ■