Hello?

How probable is it that humanity will discover the existence of an extraterrestrial intelligence within, let's say, the next twenty years? Very small, most of us would assume, although no one really knows. But if the chance is not strictly zero — if we're not truly alone in the Universe — then there is good reason to think that it's getting bigger pretty quickly. It's not crazy to believe that we might just find life outside of the Earth in the next 20 to 50 years.

It's not crazy, I think, because of the incredible pace at which astronomers are currently discovering planets in orbit around other stars. The very first such exoplanet was only identified in 1992, and the first in orbit around a Sun-like star only in 1995, when Michel Mayor and Didier Queloz discovered 51 Pegasi b, a planet about 50 light years away from Earth in the constellation Pegasus. But in the two decades since, astronomers have found about 1,500 exoplanets for sure and now know of a further, roughly 3,500 highly likely candidates (see an online database at <http://exoplanets.org/>). New studies — principally reporting results from the now defunct Kepler space telescope and from the High Accuracy Radial velocity Planet Searcher (HARPS), a high-precision spectrograph at the La Silla Observatory in Chile — offer up hundreds of newly discovered planets at a time.

Exoplanets range from very large gas giants like Jupiter, only bigger, to really tiny planets so close to their parent stars that they orbit in less than a day. A planet discovered three years ago, called HD 8512 b, has a mass only 3.6 times that of Earth and occupies the edge of the so-called habitable zone — a narrow zone around a star in which a planet with sufficient atmospheric pressure could have liquid water at its surface. Astronomers estimate that there may be 10 billion similar Earth-sized planets within the habitable zones of stars in the Milky Way alone.

Hence, researchers have naturally begun to turn large radio telescopes towards some of these planets in the hope of hearing something life-like — a form of music, perhaps, some strange language, or more likely, a signal that looks to be of unnatural origin even if we can't identify what it is.

Last year, for example, researchers from the SETI Institute searched through radiofrequency emissions in

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the band 1.1–1.9 GHz from 86 stars that host confirmed or candidate exoplanets identified by the Kepler telescope. They focused on vaguely Earth-like candidates with surface temperatures between 230 K and 380 K, and looked for narrow-band signals having spectral width less than 5 Hz, as such signals are not known to have any natural source. Unfortunately, but not surprisingly, the search turned up nothing. Hence, the researchers concluded, it's likely that fewer than about 1% of exoplanet systems currently known could have civilizations sending out radio signals in the band studied. Of course, they may be sending out something else. The SETI team is now searching instead for laser signals, and this is only the beginning of a long list of possibilities.

We're going to get a lot better, quickly, both at finding candidate planets and at studying them closely. We currently know of somewhere around 5,000 exoplanets, and the rate of their discovery is set to explode in coming decades. Last December, the European Space Agency launched its new Gaia spacecraft, which is now in orbit around a point about 1.5 million kilometres from Earth. Over the next five years, its telescopes will scrutinize roughly 1 billion stars in the Milky Way galaxy, which is about 1% of the total. Astronomers expect that Gaia, aside from boosting our understanding of galactic evolution, will ultimately detect new planetary systems numbering in the tens of thousands.

In 2017, Gaia will be followed by NASA's Transiting Exoplanet Survey Satellite (TESS), which will monitor roughly 500,000 stars relatively close to Earth; that is, within 100 light years or so. Over two years, it will look for exoplanets by detecting a dip in stellar brightness when a planet passes in front of the star as viewed from Earth. TESS is expected to find several thousand further exoplanet candidates, with some 500 or so of these expected to be Earth-sized or slightly bigger. Importantly, the exoplanets TESS does find, in orbit around relatively close

stars, will be much easier to study to learn further details such as mass, size and density.

Hence, by 2020, we should know of more than 10,000 exoplanets. By 2030, if technological sensitivity continues to grow at the current pace, we could know of hundreds of thousands, perhaps even a million exoplanets, including many existing within habitable zones and having near-Earth conditions. These will be investigated in ever greater detail. If life isn't rare in the Universe, perhaps we'll find not just one, but many civilizations.

Even if we find no intelligence, however, we will greatly expand our understanding of planetary systems. Indeed, the past decade has seen huge progress in the development of photometric and spectroscopic techniques for probing the details of exoplanetary atmospheres, either from space- or ground-based observations. More than 50 distinct exoplanets have been studied this way, turning up details on temperatures and atmospheric composition.

In combination with knowledge of planetary mass and size, scientists can now draw good inferences about the bulk composition of the planetary interior, or the fractions of volatiles and rock present in rocky planets, and even put constraints on things such as the nature of atmospheric flows. No signs of life yet, but researchers can also begin to piece together how different exoplanets formed, as scientists did over the past century for planets in our own Solar System.

It's yet more reason to believe that we're living at an extremely special period in the history of humanity. In just a whisper of biological time, our ancestors went from living in tree tops in Africa to creating science, technology and industry, to stitching the world together into a globalized whole and probing the very first moments of the Universe. We're now learning about countless other planets like our own, and coming close — perhaps — to making contact with one of them. It might actually happen, for us, or for our near descendants.

That moment of contact will be the most special moment of all, and an immensely risky one for our species. Indeed, for the entire planet. "There are only two possibilities", as Arthur C. Clarke once noted, "we're alone in the Universe or we're not. Both are equally terrifying." □

MARK BUCHANAN