are created just beyond the orbit of Mars at about 3 astronomical units (AU) and whose density increases towards the Sun, the particles around Vega, β Pictoris and Fomalhaut are created at nearly 100 AU, more than twice the orbit of Pluto, and there are holes in their distribution as they spiral in towards the stars. The central clearing inside a few tens of AU is most readily explained as the dynamical sweeping up of particles by larger bodies (presumably planets) in orbits similar to those of the Solar System.

The greater extent and mass of the particles around the distant stars compared to the zodiacal particles suggested that planet formation is continuing, that is, that the largish bodies at many tens of AU still needed time to coalesce into giant planets. To be fair, we would not yet be able to see a similar mass of particles in the outer regions of the Solar System, but our prejudice is that planet formation ceased more than 4,000 Myr ago. Therefore, the age of these other systems is an important element in our assessment of the rate at which planets are built around other stars.

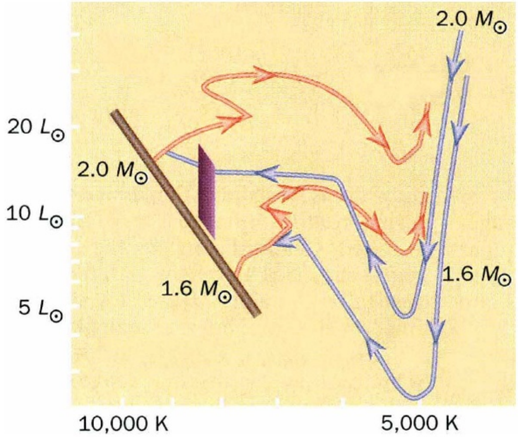

FIG. 2 The Hertzsprung–Russell diagram used by Lanz *et al.* to estimate the age of β Pictoris. The trapezoid is the error-box for the stellar location; the lines with arrows indicate the evolution of a star of a particular mass (1.6 or 2.0 solar masses, $M_\odot$) over time. It takes approximately 20 Myr to evolve from the top right corner to the main sequence (grey line); a star spends approximately 300 Myr on the main sequence before evolving up and to the right in the diagram.

Estimating stellar age normally relies on a measurement of the luminosity and temperature of the surface compared to theoretical calculations of how these quantities change with time for a star of a given mass. Figure 2 shows the measured position of β Pictoris in the luminosity–effective temperature diagram (called a Hertzsprung–Russell diagram) together with evolutionary tracks calculated from stellar models. The trapezoidal region delineates Lanz and colleagues' best estimate for the position of the star after accounting for interstellar extinction. Unfortunately, the region is consistent either with a very young star, 12 Myr old, just moving onto the grey line (the main sequence) or a relatively old star, more than 300 Myr old, just moving off the main sequence line after considerable evolution.

Unfortunately, the ambiguity of the age diminishes the significance of the new result. The authors favour the younger age simply because the particle disk around the star is much denser than any other examples detected to date. If β Pictoris is only 12 Myr old — the preferred solution — there has probably not been sufficient time to create giant planets such as Jupiter, but Earth-sized planets could have arisen. On the other hand, the transient particle lifetimes are easier to understand as the remnants of a much larger reservoir remaining from the initial collapse of the nebula during stellar birth. An older age for the star leaves open the question of why β Pictoris is unusual in its large particle density, although it would be easier to explain the particles as collisions from larger bodies in orbit. Clearing of the inner hole by smallish (Earth-sized) planets orbiting at a few tens of astronomical units could occur for either age.

Although useful, this new estimate of the age leaves open the issue of whether very large bodies orbit the star. Our conventional theories suggest a few large protoplanets can grow by runaway accretion in about 1 Myr (ref. 9). Subsequent growth of giant planets requires 10 to 100 times as long. If the young age for the star can be confirmed, it implies that the formation of giant planets has not taken place but is happening now. That holds out the tantalizing possibility of training future telescopes or interferometers on β Pictoris to witness the processes that assembled the giant planets in our own Solar System long before we were around to appreciate their significance. ☐

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DAEDALUS

Steam speaks!

DAEDALUS deplores the conventional loudspeaker. Its clumsy vibrating cone reproduces the high frequencies very crudely; and it is so small compared with bass wavelengths that it radiates them very badly. He now has a new idea.

He points out that the vapour pressure of any liquid rises with temperature, and very dramatically compared with sound pressures. He calculates that the vapour pressure change from heating water by a mere 0.01 °C could generate a thunderous 100-dB sound-pulse. A sheet of water could create deafeningly loud sound simply by minor fluctuations of surface warmth. But how to do it at the kilohertz rates required for sound reproduction?

Daedalus's cunning idea is to heat, not the whole mass of water, but merely its surface. Not only does this save power; the bulk of the water stays cold, and cools the surface instantly when that power is withdrawn. Both heating and cooling can thus be carried out very rapidly. He has two ideas for heating a water surface selectively. The first is to dope it with a detergent whose ions cluster at the surface. (This is the effect which stabilizes detergent foam.) Because water conducts electricity via dissolved ions, an audio signal passed through such a solution should selectively heat its surface. His other scheme exploits the 'skin effect' which limits high-frequency current to the surface of a conductor. By modulating an inaudibly high 'bias frequency' with the output from an audio amplifier, audio-frequency heating could again be confined to the water surface.

A tank of warm water, however, is an inconvenient loudspeaker. The commercial version will be a sort of vertically hanging wet blanket, with electrodes round the edge. It will be shrouded in a loose but sealed enclosure of sound-transparent plastic film, containing a small dehumidifier to condense evolved vapour and return it to the blanket.

Cheap, simple and with no moving parts, DREADCO's 'Steam Speaker' will transform sound reproduction. It will handle the loudest and most complex sound with authoritative high fidelity. A big enough version could match the longest sonic wavelength, and its acreage of surface could radiate kilowatts of pure thunderous bass. Even rock musicians will cringe at the power available to them. More thunderous still, its output could be focused by curving the wet blanket, or by using many Steam Speakers as a phased array. Assault, demolition, rain-making by vibrating the clouds and even anti-aircraft duties seem feasible.

David Jones