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SOLAR SYSTEMS LIKE OURS

Ken Tapping, 23rd September, 2014

Thanks to improved telescopes and other astronomical instruments, we now know that most stars have planets. At first we could only detect really large planets, like Jupiter, but now we are finding planets the size of the Earth. Our ideas about the formation of stars suggest that whenever a star forms, a retinue of planets is formed too. However, most of the planetary systems we find orbiting other stars are bizarrely different from ours, which we refer to as the Solar System.

We expected that those other planetary systems would be more or less like ours: small, rocky planets close in, and large, gas giant planets further out. This logical concept is centuries old. Pierre-Simon Laplace, the French astronomer and mathematician formulated it in the late 18th Century. The idea is that stars and planetary systems form from the collapse of a cloud of cosmic gas and dust. The cloud forms a disc, which then forms a star at the centre and planets orbiting it. The radiation from the newborn star evaporates volatile materials from the nearer planets, leaving them as small rock balls. Further out, those materials are not evaporated, so the planets are larger, and mostly consisting of gas. In the Solar System, the rock balls are Mercury, Venus, Earth and Mars, and the gas giants are Jupiter, Saturn, Uranus and Neptune. The picture is logical and we expected it everywhere else.

That's not what we found. In many cases we have found gas giant planets orbiting extremely close to stars; in some cases so close they take days to complete one orbit. Mercury, the closest known planet to the Sun takes 88 days, and Jupiter, the gas giant planet closest to the Sun takes 12 years. It's likely that a gas giant planet close to a star will have its gases and other volatile material cooked off in a short time – in astronomical terms. So there are two rather disquieting issues here: firstly how can the orbits of planets be so drastically changed, and secondly, it cannot have been that long ago, because by now the planet would have become a rock ball.

Our Solar System formed about 4.5 billion years ago. The oldest rocks on Earth that bear evidence of living things were laid down about 3.5 billion years ago. We believe that life as we know it began in the sea and required permanent oceans to survive and evolve. It appears that life appeared on Earth as soon as the planet had cooled enough for water to accumulate on its surface. Since even a tiny change in the Earth's distance from the Sun could freeze or fry us, we can assume that nothing drastic has happened to the Earth's orbit for at least the last 3.5 billion years – most of the life of the Solar System. It has been suggested that ice ages are caused by really microscopic changes in the Earth's orbit. This stability does not fit well with what we are seeing with other planetary systems. This has led to an increasing effort to research the behaviour of multiple planets orbiting a star.

The physics is relatively simple; we have several bodies tugging at each other with their gravity. The problem is that the simple calculations have to be done millions or billions of times. However, computers are really good for this sort of work. The results are somewhat disquieting, in that they show planets perturbing each other into dramatic changes in their orbits. The calculations bear out what we are seeing with other planetary systems. This is leading to extensive work into modelling the history of the Solar System, to see what sort of juggling act might have gone on, which still left our planet alone for at least 3.5 billion years.

The Sun crosses the celestial equator on the 22nd, marking the Autumn Equinox. Venus is getting lost in the sunrise glare. Jupiter rises in the early hours. Saturn and Mars lie close together, very low in the sunset twilight. The Moon will be New on the 23rd and will reach First Quarter on 1st October.

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