DASC and Kepler

A new challenge

Kepler is a NASA satellite that will be launched in February 2009. On board the satellite is a photometer capable of continuously measuring the brightness of about 170000 stars in or near the constellation of the Swan (Cygnus).

None of these thousands of stars is visible to the naked eye, but by using even a relatively small telescope in space we will be able to measure even the slightest changes in brightness in any of these many stars.

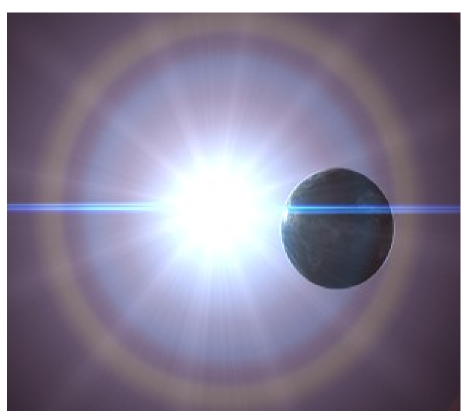
Worlds Away

The aim of the mission is to find planets the size of the Earth, orbiting other stars in the Milky Way - in orbits that allow for liquid water to be present on the planet's surface. If the planet is too close to its star, the surface will be too hot, if the planet is too distant, any water on the surface will be frozen.

The gas giant Jupiter in comparison to Earth

Just as the Earth is orbiting our Sun at a distance allowing liquid water to be present, earth-like planets are assumed to be present around other stars as well. But they are very difficult to find, because they are so small (compared to the stars), and so far away. Larger planets, on the other hand, are easier to find. At present, more than 250 planets orbiting other stars are known. Most of these are of the size of Jupiter, thus much larger than the Earth, while the smallest of the known exo-planets, as they are called, are about 5-7 times more massive than the Earth.

The first exo-planet was found in 1995, and the fact that over 250 more have followed since then, with new ones found every month, suggests that many of the stars in the Milky Way actually have planets. Thus, planets the size of Earth may also be common - but we just can't detect them with our present technology.



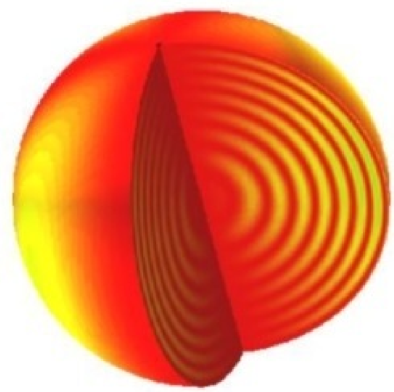
However, if a small planet in its orbit around a distant star passes in the line-of-sight between us and the star, the planet will cause a slight dimming of the brightness of that star. This is called a planet transit and the method has already now been used from the ground to detect more than a handful of the know exo-planets.

All the known transiting planets are relatively large. The change in the star's brightness is proportional to the ratio of the planets surface area to the surface area of the star, and in order for us to detect it from the ground, the brightness change has to be relatively large. This is because of disturbances from the Earth's atmosphere which set a lower limit as to how precisely we can measure stellar brightness from the ground. A small, earth-sized planet passing in front of it's distant star, as seen from the Earth, will cause such a slight dimming of the starlight that it will be impossible to observe it from ground.

But the disturbing effects of the atmosphere are obviously not a problem when observing from space. Therefore, launching even a relatively small, 1-m sized telescope into space makes observations, which cannot be obtained even with the largest telescopes from ground, possible - observations precise enough to detect earth-like planets around other stars.

Looking inside the Stars

However, this technique of continuously monitoring the brightness of thousands of stars to a very high degree of precision brings about other scientific possibilities, too. There are other mechanisms that cause variations in a star's brightness, mechanisms which are connected to the star itself. These can be processes on the surface of the star - starspots, for instance - or, more importantly in the present context, processes in the interior of the star, which cause the star to vibrate, or rather oscillate.



Such stellar oscillations, or starquakes, introduce small, periodic variations in the brightness of stars. The oscillations, where the gas in the star is continuously compressed and decompressed, actually corresponds to sound waves here on Earth. They are well-defined tones, excited by physical processes inside the star and, generally speaking, one can say that large stars oscillate in low tones, smaller stars in higher.

There are big differences in how different stars oscillate.
Some stars oscillate in only a few tones, others in quite a lot, in some stars the variations in brightness are large, in other very small. It is actually possible to categorize pulsating stars from the way their brightness changes and it turns out that stars, oscillating in about the same way are also physically quite similar - having about the same mass and age. The situation is the same for humans: our voices all sound more or less alike, but each voice is, in fact, unique. Likewise, no two stars oscillate in precisely the same way.

At the *Danish AsteroSeismology Centre* (**DASC**) we are working on understanding the life and inner structure of stars, using stellar oscillations. Much like geologists use earthquakes to infer the interior structure of the Earth, astronomers use starquakes to determine the interior structure of stars. This branch of science is called asteroseismology and this is the subject of these pages.

DASC is involved in the *Kepler* project, as we are coordinating the use of the *Kepler* data to learn about the inner structure of stars, using asteroseismology. On the following pages you can read much more about how asteroseismology works, and why *Kepler* will provide a fantastic dataset for looking inside the stars with this technique. When you have studied these pages, follow the link to the *Kepler* homepage to learn more about how exactly *Kepler* will detect earth-like planets in orbits around other stars.

The Kepler Homepage