

A month in the USA



Professor Chaplin's research trip to the USA is a great opportunity for one of the University's leading scientist to work together with other experts studying the **'music of the stars'** (</research/our/news/items/stars-orchestra.aspx>) from around the world; brainstorming, discussing and exchanging new ideas in the thriving Californian academic environment.

Professor Chaplin (</staff/profiles/physics/chaplin-william.aspx>) leads the programme of the NASA Kepler Mission devoted to the asteroseismic investigation of solar-type stars, managing and coordinating the work of 170 international scientists. He is co-author on over 150 research papers in scientific journals (with an H-index of 32), in the fields of solar and stellar physics.

He is also the author of a book on helioseismology. He is actively engaged in promoting solar and stellar research in both national and international media, including recent appearances on the BBC to discuss results from Kepler.

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Revolutionary results - Sunday 11 December 21.03 (GMT)

Today is the last full day of my trip to the US.

This week's Kepler conference was fantastic, with many presentations on the revolutionary results it is providing on exoplanets and stellar astrophysics. One must always be cautious adopting terms like "revolutionary" when it comes to science, but in the case of Kepler it is certainly no understatement to say that the use of the word is appropriate.

Friday highlighted asteroseismology, and in my talk I presented a summary of the work being conducted by over 100 scientists studying solar-type stars by observing their oscillations with Kepler. I also presented results on the 50 Kepler Objects of Interest (KOI) - stars having candidate planets - where we have also detected oscillations. One of those stars is orbited by Kepler 22-b, the small, habitable exoplanet whose discovery was announced at the start of the meeting. Without the asteroseismology it would not have been possible to state with such confidence that the planet lies in the habitable zone of the star.

Tomorrow I head home, flying from San Francisco to Heathrow. Having spent four-and-a-half weeks in the US, my body-clock has fully adjusted to West Coast time. A further bout of jet-lag to come! But it'll be great to be home.

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Exciting exoplanet result - Tuesday 6 December 05.00 (GMT)

Over the weekend I travelled up the California coast, on AMTRAK, to San Jose in the bay area for the first NASA Kepler Science Conference.

The conference is being held at NASA Ames Research Center, with 450 scientists who study exoplanets and stars in attendance. I give my review talk later in the week, on the fantastic results we have from asteroseismology of solar-type stars.

This morning began with a big press conference, and the announcement of the discovery of the first confirmed planet found by Kepler that is orbiting in the "habitable zone" of its host star (see: <http://www.bbc.co.uk/news/science-environment-16040655> (<http://www.bbc.co.uk/news/science-environment-16040655>)). Three scientists from Birmingham - me, and two of my colleagues, **Yvonne Elsworth** (</staff/profiles/physics/elsworth-yvonne.aspx>) and **Andrea Miglio** (</staff/profiles/physics/miglio-andrea.aspx>) - are co-authors on the paper. We are part of the team that provided extremely precise estimates of the properties of the host star, using asteroseismology. From these results, we know that the host star has very similar properties to our own Sun: It is just a little bit smaller, and a little less massive, than the Sun, and also a touch cooler. The newly discovered planet - which has a radius 2.4-times that of the Earth - takes around nine-and-a-half months to orbit the star. The Kepler Mission is edging closer and closer to finding the first Earth-sized planet. Exciting results indeed.

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Analysing KOIs - Thursday 1 December 04.08 (GMT)

My stay at the Kavli Institute for Theoretical Physics is nearly over: just two full days left before I head north on Saturday to San Jose for the first NASA Kepler conference (on which more next week).

We have been enjoying clear blue skies and temperatures in the low to mid 20s. But I shouldn't dwell too much on the weather! After Kepler target selection last week, this week my focus has been on several science projects, and preparation for next week's NASA meeting.

The Kepler satellite is monitoring the brightness of around 150,000 stars, the aim being to detect Earth-sized planets orbiting stars like our Sun.

I've been analysing some of the stars observed by Kepler that have candidate planets. These stars are called Kepler Objects of Interest, or KOIs. They have already been flagged because a tiny, regularly repeating dimming of their starlight has been recorded, which could be the signature of a planet passing in front of the star. The exoplanet team then perform a series of exhaustive, meticulous checks in order to rule out all other possible causes that might explain the observations: If all goes well, and other explanations are ruled out, the team can then state with confidence that a new planet has been found around another star.

I am one of the coordinators of an asteroseismology team that is looking for oscillations in stars that are KOIs. If we can detect oscillations we can then provide invaluable information for understanding these newly discovered "planetary systems". For example, our asteroseismic data allow us to measure the sizes of the host stars to great accuracy and precision. That information is required in order to obtain an absolute measure of the size of the discovered planet. Next, we can measure the intrinsic brightness of the star. With that property in hand, it is possible to determine whether the planet lies in the so-called "Goldilocks" or "habitable" zone around the star, the region that is not too hot, and not too cold, but just right for there to be liquid water. Finally, if one has found a small planet in the habitable zone, one might very well then ask: how old is the planet? Might sufficient time have lapsed for life to evolve? Here, asteroseismology can again provide an answer, since by giving a precise age for the

star, we can therefore provide a good estimate of the age of the planet.

Next week, I shall be giving an overview of the haul of KOIs that also show oscillations: our "asteroseismic Zoo" of candidate exoplanet hosts.

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Pick a star... make a wish - Friday 25 November 01.02 (GMT)

It is now the second week of my three-week-long stay at the Kavli Institute for Theoretical Physics, and the time seems to be flying by.

I'm into a settled daily routine of attending talks and presentations (one already with me as presenter), and impromptu discussions in the corridor with familiar and new faces. I've had the chance to push forward scientific investigations with established collaborators who are also here at the institute; and to make new links and to start new work.

Much of my time has been spent discussing which stars we would like to observe with the NASA Kepler Mission. Each quarter, the asteroseismology team has to decide on its target list, i.e., the stars for which we will receive data here on the ground. We recently confirmed our list for the forty third month of science operations, and that list is looking very settled: We have known for a while which stars are the best ones to look at to boost our science return. They are, by and large, the brightest ones observed by Kepler; a little too faint to be observed with the naked eye, but more than bright enough to produce exquisite data of unprecedented quality (real "gold dust" to us astronomers). We've already been able to peer inside stars not dissimilar to our own Sun, to see how rapidly they are spinning. We have also started to look at whether they are also showing cyclic changes in activity (like the "bio-rhythm" of the Sun's 11-year sunspot cycle).

We are hoping that the mission will be extended beyond its nominal 3.5-year lifetime, and as part of making the case to extend the observations we have been choosing the targets we would like to see observed, continually, for another 3.5 years. There are so many stars with beautiful data that this has not been an easy choice. We had a telecon on Wednesday to discuss the issues, and the list now needs to be finalized. (The telecon was due to begin at 6.00am local time, which meant I had to catch a 5.30am bus, which never showed up... fortunately by the time I arrived at the institute, around 45 minutes later, I discovered that the telecon had anyway been delayed).

With that, I see it is time for more coffee (and cookies...).

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Coffee and cookies time - Thursday 17 November 01.36 (GMT)

I have just begun a 4-week research trip to California. After flying into Los Angeles, I head two hours north by car to Santa Barbara, where I'll be based for the first three weeks. The Kavli Institute for Theoretical Physics is hosting

around 30 astronomers who study the "music of the stars", natural resonances caused by sound trapped in the interiors of the stars (which makes them ring like musical instruments). I am one of these "asteroseismologists", and this programme is giving us a wonderful opportunity to brain-storm, discuss and exchange new ideas in what is an extremely pleasant environment to say the least (a bit of English understatement there regarding Santa Barbara and its local environs).

As I write this, I'm three days into my 3-week stay, still fighting jet-lag (my body does not like the 8 hour time difference) but brim full of ideas from the first meetings I have had with my colleagues. My main research is geared around using data from the NASA Kepler Mission (which is searching for planets around other stars). I lead an international consortium studying the resonances of stars that are similar to our own Sun. This week we've been discussing some of the oldest stars that we've observed which are not that much younger than the universe (the Sun is by comparison "middle aged"). From looking in detail at just one star, we can actually say something about the history of our galaxy: cosmic archaeology, if you like, all given away by tell-tale properties of the star.

Time for caffeine: It's coffee and cookies time, a daily afternoon ritual here at the institute.