Stellar Astrophysics Centre 2018

A happy moment shortly before launch of Delphini-1 in December 2018 from Kennedy Space Center, USA

Scientific highlights of the year

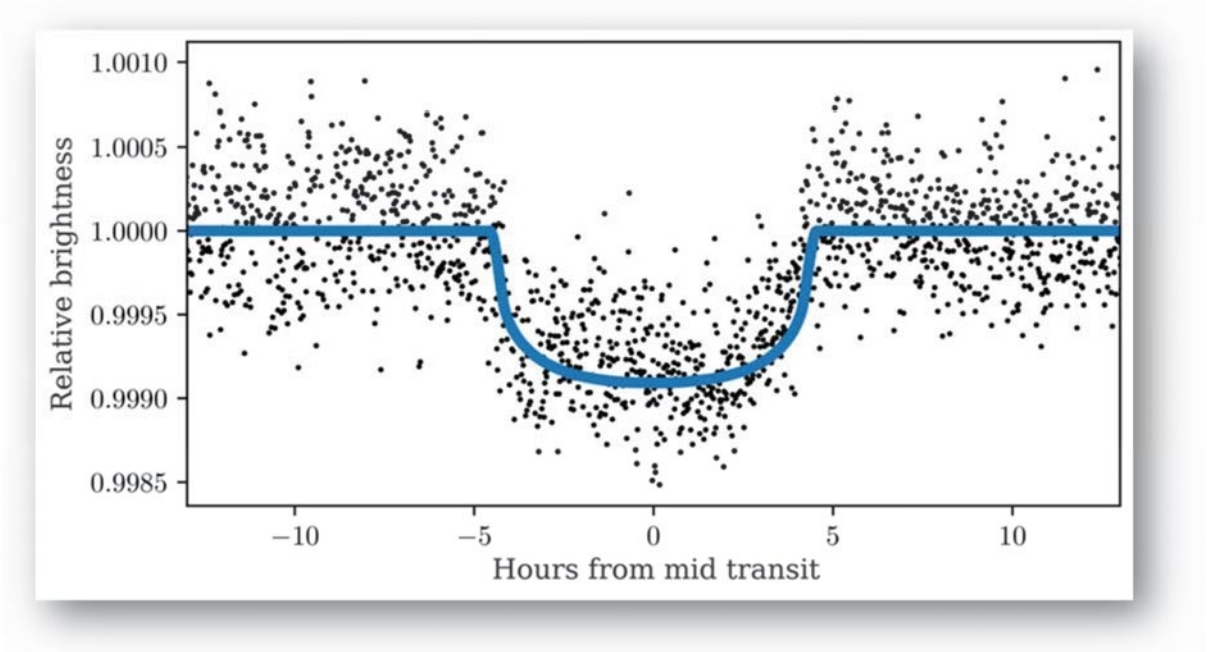
The Stellar Astrophysics Centre (SAC) had a successful kick-off of the second phase of the Centre on 1 April 2018. Throughout the existence of SAC many of our staff members have developed new science activities and have obtained additional funding to expand those activities. We continue to maintain our leading position within a broad range of research activities from stars and stellar environment to galactic archaeology, exoplanet properties and evolution as well as astrobiology.

We are in the phase of expanding one of our prime research facilities - The Stellar Observations Network Group – with two new telescopes in Australia. This is a result of Danish funding as well as a research collaboration with University of Southern Queensland, University of Sydney, University of New South Wales, Monash University and Australian National University. The new facility which is expected to start operations in the beginning of 2020 consists of two 70 cm telescopes equipped with a Danish-funded spectrograph. The telescopes will be placed at the Mt Kent Observatory in Southern Queensland in Australia and will be robotic and will be controlled from Aarhus University.

A robotic telescope at Mt Kent in Queensland, Australia similar to one of the new SONG telescopes

We continue to use space missions for our studies of stars and exoplanets. The space data are primarily from the Kepler/K2 mission that ended operations in 2018 after 9 years. SAC is deeply involved in planning the science programme for the TESS {NASA) mission that was launched from Kennedy Space Center in April 2018. The science for stellar astrophysics is organized and led by SAC researchers under the TESS Asteroseismic Science Consortium {TASC). SAC is hosting an astronomical network platform used to facilitate the international collaborations within TASC: http://tasoc.dk. Also organized by SAC is the TESS Data for Asteroseismology {T'DA) workshop series where several workshops were held in 2018. The purpose of the workshops is to prepare for an efficient facilitation of high-quality data for asteroseismology from the TESS mission. In July 2018 SAC hosted a large international workshop with 160 participants. This TASC4/KASC11 workshop focused on the use of TESS data to detect stellar oscillations and measure properties of stars and exoplanets.

The first scientific results from TESS are now being published with substantial and significant contributions from the SAC research staff. This is the first example where data from TESS were used to do asteroseismology on a star containing an exoplanet and at the same time observed by ground-based telescopes including a large number of data from the Hertzsprung SONG Telescope on Tenerife. This newly discovered exoplanet {TOI-197.01) is a Saturn-like gas planet that orbits around its star with a period of only 14 days. The studies show that the planet has a density of only 1/13 of the Earth's density and a mass that is approx. 60 times the Earth's mass. The age of the planet, a bit more than 5 billion years, is slightly older than the Earth. With the results of this study TOI-197.01 is one of the best described exoplanets of this type to date.



Light curve from TESS of the star TOI-197 during the time the planet passes in front of the star and thus shadows part of the star's light. The black points are data from TESS and the blue curve is the model that best describes the observed data

In a study of the exoplanet WASP-33b, led by researchers from SAC**,** the OSIRIS spectrograph on the Gran Telescopio Canarias {GTC) on La Palma, Spain was used to detect aluminium oxide in the atmosphere of an Ultra Hot Jupiter with an equilibrium temperature around 3,200 C**.** Studies like this indicate that one is able to measure properties of exoplanet atmospheres, a technique that in the future will be used to search for biosignatures in Earth-like exoplanets.

Artist impression of WASP-33b – an ultra hot Jupiter with Aluminium oxide in the atmosphere.

The magnetic field of a star create stellar activity that we can observe as star spots. Those dark spots appear in places where the star's magnetic field is highly concentrated. One way researchers have catalogued stellar activity for our Sun is to construct a so-called butterfly diagram illustrating the latitude of star spots on the surface of the Sun. Researchers, including researchers from SAC, have now for the first time been able to create a similar butterfly diagram for another star. The diagram was constructed using asteroseismic data from the Kepler-mission for the Sun-like star HD 17370. The used approach highlights the potential power of asteroseismology for learning more about stellar magnetic field.

SAC has initiated a new space activity in collaboration with the Department of Engineering, Department of Physics and Astronomy, Department of Geoscience and the Danish company GOMSpace. The first success of this activity was the launch of Delphini-1. This small satellite (10 cm x 10 cm x 10 cm) is focused on operation and communication. Delphini-1, which is the first Aarhus University satellite, is now in orbit around the Earth. The launch, provided for free by the European Space Agency ESA, occurred in December 2018 under a bright blue sky from the Kennedy Space Center, watched eagerly by a group of our students and employees, involved in assembling and testing the satellite. The first data from the satellite are now on ground and show that the satellite's camera is working according to specifications.