Stellar Astrophysics Centre 2019

One of the new SONG 70 cm telescopes at Mt Kent, Queensland, Australia. (photo: Mads Fredslund Andersen)

Scientific highlights of the year

The Stellar Astrophysics Centre (SAC) at Aarhus University continues 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 developing one of our prime research facilities – The Stellar Observations Network Group – with two new telescopes in Australia that are being constructed at Mt Kent at present (spring 2020). We continue to use space missions for our studies of stars and exoplanets with SAC leading the planning of the asteroseismic component of the science programme for the TESS (NASA) mission. We also continue our use of several world-class facilities such as the Nordic Optical Telescope and the telescopes in Chile run by the European Southern Observatory. The Delphini-1 Cube satellite – Aarhus Universities first satellite – was released from the International Space Station (ISS) on 31 January 2019 and has been operating from a low-earth orbit throughout 2019 and is expected to stay in orbit until sometime in 2021.

The SAC staff has published many results in 2019 in relation to exoplanet research. Several SAC researchers took part in a study of the Kepler-107 exoplanet system showing that an enormous exoplanetary collision might be the cause of unusual mass distribution in this system. The exoplanet named Kepler-107b seems to be a quite ordinary rocky planet orbiting the Solar-like star Kepler-107 in just 3.1 days. The twin planet to Kepler-107b in size, Kepler-107c, is further out, but still close with an orbital period of 4.9 days, and with a weird property that contradicts simple theories: Kepler-107c is by far the densest of the two. This is contradictory to current ideas of planetary formation, and as the researchers

behind the study rule out some more obvious explanations like exoplanet migration, something else must be the cause. The study seems to indicate that Kepler-107c is the remnant of a collision between two large planets, leaving most of the dense metals in the planet that we see today.

An international team of astronomers that includes Carolina Von Essen from SAC detected, for the first time with a clear significance, the chemical element potassium in the atmosphere of an exoplanet. The Potsdam Echelle Polarimetric and Spectroscopic Instrument (PEPSI) at the Large Binocular Telescope (LBT) in Arizona was used to study the atmosphere on the Jupiter-like exoplanet HD189733b. With these new measurements, researchers can now compare the absorption signals of potassium and sodium and thus learn more about processes such as condensation or photo-ionization in these exoplanet atmospheres.

Tina Šantl-Temkiv from SAC is leading a project aiming at collecting air samples and samples of sea ice and water in order to determine the amount and types of aerosols - particles in the atmosphere - in the environment in Antartica. The aim of the study is ultimately to find out if these bioaerosols can be used to determine if there is life on some of the exoplanets, and the goal of the project is to obtain a global overview of the amount and types of bioaerosols in the atmosphere and show their influence on weather and climate. Tina Šantl-Temkiv stayed on Antarctica for a month in 2019 and after returning to Aarhus with the samples, they will now be compared with similar results that have previously been obtained in and around Greenland.

Tina Šantl-Temkiv from SAC at the Juan Carlos I Antarctic Research Station

Based on data from the TESS satellite researchers from TASC - including Victoria Antoci from SAC - found the fastest known so-called roAp pulsator. The star completes one pulsation every 4.7 minutes and this finding is important because it allows us to use the observed pulsations to study the interior of those peculiar stars. The roAp-stars show several strange phenomena such as chemical spots at the surface of the star and are known to have a strong magnetic field.

A team including professor Jørgen Christensen-Dalsgaard from SAC reported in 2019 a thorough recalculation of the theory of part of the late stages of stellar evolution. The team showed that in a class of compact stars related to the so-called red giants, but lacking their outer layers, the internal helium flash that many stars will experience in the late phases of their evolution will cause small oscillations in the brightness of the star. instabilities related to the flash cause waves that propagate through the star and can be observed on its surface. The size of the resulting variations are small but large enough to allow the NASA satellite TESS to observe it if it happens in a relatively nearby star of this type. In contrast to these compact stars the corresponding variations in more sunlike stars would drown in other variations as the outer parts of the star seethe and boil. The study shows that one might be able to use the TESS satellite data to study this violent phase in stellar evolution, and the team is now searching for good stellar candidates to observe this effect predicted by the theoretical study.