Report on the ELSA School on

The Science of Gaia

held at the Lorentz Center, Leiden, the Netherlands, 19–28 November 2007

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From 19–28 November 2007, the ELSA school on the science of Gaia was held at the Lorentz Center. Gaia is the European Space Agency mission which will provide a stereoscopic census of our Galaxy through the measurement of high-accuracy astrometry, radial velocities and multi-colour photometry. Gaia is scheduled for launch in late 2011 and over the course of its five-year mission will measure parallaxes and proper motions for every object in the sky brighter than magnitude 20 – amounting to about 1 billion stars, galaxies, quasars and Solar System objects. It will achieve an astrometric accuracy of 12–25 micro-arcseconds, depending on colour, at 15th magnitude and 100–300 micro-arcseconds at 20th magnitude. Multi-colour photometry will be obtained for all objects by means of low-resolution spectrophotometry between 330 and 1000 nm. In addition, radial velocities with a precision of 1–15 km/s will be measured for all objects to 17th magnitude.

ELSA (European Leadership in Space Astrometry) is a Marie-Curie research training network which brings together world-leading expertise in space astrometry, the use of space platforms for mapping the three-dimensional structure of our Galaxy, with specialists on numerical algorithms and software engineering for the double purpose of: (1) preparing for the scientific exploitation of data from the Gaia mission; and (2) training the next generation of researchers in this uniquely European specialty to maintain and extend European leadership in space astrometry.

The primary goal of ELSA is to develop a new theoretical understanding of the conceptual, physical, and numerical aspects of space astrometry and turn this understanding into practical analysis tools which will form an essential contribution towards the Gaia data processing system. The organisers of the school felt that it is important from the outset that the young researchers in this network have a solid understanding of the science goals of the Gaia mission in order to provide them with the proper background and motivation for the specific research they will undertake. Further, bringing the potential 'end-users' of the Gaia data together with the community involved in preparing for and running the mission, would foster very valuable contacts and mutual understanding.

The lecture programme was of general interest to anyone interested in the Gaia mission and the school was also open to participants from outside the ELSA network. 25 students participated in the school which was also attended by the scientists in charge of the network nodes. Including the lecturers there was a total of 54 participants.

The programme in the first week consisted of two 90-minute lectures in the morning followed in the afternoon by exercises that the students had to carry out in groups. The lectures covered the following topics: stellar evolution; stellar atmospheres; structure and dynamics of the Galaxy and the Local Group; formation and evolution of the Galaxy in a cosmological context; chemical enrichment history of the Galaxy as encoded in its stars; binaries; exoplanets; fundamental physics; and dynamics and physical properties of small Solar System bodies.

The afternoon exercises were intended to let the students actually work actively on some of the topics discussed during the lectures and so create a more workshop-like atmosphere. The exercises were designed by the lecturers together with the ELSA scientists in charge. The students were divided into groups of two to four people and they worked on exercises covering for example: population synthesis and stellar content of galaxies; estimating the photocentre-barycentre discrepancy for observations of Solar System objects; computing a relativistic astrometric model; and working with SDSS data to detect the Sagittarius stream. The results of the exercises were presented by the students and discussed on the last afternoon of the first week. In addition all the students brought posters on their work which they presented during a mid-week afternoon session.

The lectures in the second week were devoted to more ELSA-specific issues. An introduction to GRID computing was given by a representative from Dutch Space BV through a very interesting role-playing game in which the participants had to take on the roles of the various components in a GRID architecture. There were three lectures on how space projects are realised by ESA and its industrial partners and the final two lectures concentrated on the interpretation of astrometric data and the Gaia mission in the context of other large surveys. This rounded out the lecture programme which, in combination with the exercises, was very successful in providing the students with a broad introduction to the science of Gaia and fostered a real sense of being together in a large and exciting project.

Photo: A. Brown, Leiden University

Introduction to GRID computing: Participants taking on the roles of various components in a GRID architecture.

The Lorentz Center

The Lorentz Center in Leiden is an international centre that coordinates and hosts high-visibility workshops in the sciences, in particular physics, astronomy, mathematics, computer science and the life sciences. The focus is on new collaborations and interactions between scientists from different countries, fields, and levels of seniority. The Center offers substantial logistic as well as financial support for such workshops. Astronomers who are planning an international workshop or group meeting are invited to consider the Lorentz Center; more information can be found at *www.lorentzcenter.nl*.

Fellows at ESO

Lise Christensen

Growing up in a city, I never saw the Milky Way with my own eyes until the age of 16, and I could never identify more than two constellations. I was not at all certain that astronomy was the most interesting field of natural sciences that one could study until an observing trip to La Silla during my undergraduate studies finally convinced me.

After obtaining my Masters degree from the University of Copenhagen, where I studied images of the host galaxies of Gamma-ray bursts, I wanted to gain experience with spectroscopy. In 2002 the instrumentation division in the Potsdam Astrophysical Institute had recently commissioned a new integral-field unit (IFU) for the 3.5-m telescope at Calar Alto. Data from this instrument (PMAS) were to form the basis for my Ph.D. thesis, and it turned out to be quite a challenge to find the faint Lyman-alpha emitting galaxies that are responsible for strong absorption lines in the spectra of background quasars. After finishing my thesis in 2005, I immediately started as a fellow on Paranal, and having knowledge about IFU data naturally led me to the position as a VIMOS instrument fellow.

My scientific interests are inclined towards galaxies in the high-redshift Universe. Instead of using traditional large surveys with flux-limited samples of galaxies, I have used other selection criteria in order to locate and study either the more common or unusual galaxies that existed in the early Universe. The experience with IFU data has allowed me to gain insight into different types of scientific projects that can be done with the same data sets, such as searching for field Lyman-alpha emitters or looking at quasar environments. Besides, working at ESO has given me the freedom and opportunity to work with several people on various projects that are outside my main scientific path.

Sune Toft

I did my Masters and Ph.D. studies at the Niels Bohr Institute, University of Copenhagen. During my first years of studying physics, I became very interested in the philosophical aspects of physics, and discovered that astronomy, in particular cosmology, was a natural framework to pursue this interest. I was fascinated by cosmologist's attempts to develop a model for the entire Universe, despite the limited amount of observational constraints available at the time.

One of the best ways to constrain cosmology is to study the build-up of mass as a function of cosmic time. Observations of high-redshift galaxies provide the strongest constraints. For my Ph.D. thesis I used deep near-infrared (NIR) observations obtained with the VLT to study galaxy evolution in high-redshift clusters of galaxies. I spent seven months at the Institute of Astronomy in Hawaii, where I had the opportunity to observe with several of the big telescopes on Mauna Kea. I also had prolonged collaborative visits to ESO and Leiden.

In 2003 I received my Ph.D. and moved to the United States where I took up a postdoc position at Yale University. There I started working on a newly discovered population of NIR-selected massive, high-redshift galaxies. Working in the U.S. was very interesting, and I seriously considered staying for a second postdoc, but when in 2006 I had the opportunity to return to Europe for an ESO fellowship, I didn't hesitate. I have been very happy with this decision. ESO is a stimulating place to work, with lots of stuff going on (talks, workshops, etc). For my functional work I have become involved in the planning of the ELT, a project with great momentum which is exciting to be part of, and besides that I have plenty of time to pursue my own independent research programme.