Knowledge Transfer is central to efforts to improve our understanding of science, particularly in areas like astro-physics, which offer seemingly infinite opportunities for further research. It is in this context that the ASTRONS project must be viewed, says Prof. M. Ali Alpar of Sabanci University.

The great expanses of space offer enormous opportunities for us to improve our understanding of our own world. Nations across the world are keen to capitalise on this potential, and Turkey is no exception. Take the ASTRONS (ASTROphysics of Neutron Stars) project, which was established with the overall goal of ‘preparing Turkish astronomers for the XEUS era’. When the project took off it was planned that XEUS (the X-ray Evolving Universe Spectroscopy Mission) would be the next flagship mission of the European Space Agency (ESA) in the X-ray domain, with an effective area 10 times the size of the largest X-ray telescope operating in space today (the XMM-Newton).

When finished, XEUS would revolutionise the neutron star field. In order to get the most out of this mission Turkish astronomers at Sabanci University’s (SU) Astrophysics and Space Forum in Istanbul, which is open to all Turkish high energy astrophysicists, decided that they wanted to be involved at every stage of the process, including instrument development. ASTRONS partners have been chosen from institutes that are directly involved with both the science case and the instrumental aspects of the mission. This emphasis on knowledge transfer has allowed Turkish astronomers to be closely involved in the development of XEUS. After having been accepted for the Phase A study in ESA’s (European Space Agency) Cosmic Vision programme, XEUS has now been merged with NASA’s similar flagship mission Constellation X, joined forces with the Japanese Space Agency and renamed International X-ray Observatory (IXO). However, the fundamental goals of the mission have not changed, and neither have ours. We want Turkish astronomers to be ready when IXO is launched.

Transfer of knowledge is the main aspect of the ASTRONS project, and we aim to aid information flow between established European institutions and SU Astrophysics and Space Forum. With this in mind distinguished visitors have...
shared their knowledge on neutron stars and high energy instrumentation. Each of these guests has started individual projects with the staff and/or graduate students at SU. For example, Dr Tomaso Belloni of INAF, Brera, has established a project comparing the timing properties of neutron stars and black holes. Dr Marat Gilfanov of MPA works with a researcher and also a PhD student on X-ray spectral fit models that include Compton scattering of low energy photons through high energy electron corona. Meanwhile Dr Lund of the DTU-Space helps out on the instrumentation aspect of the project, advising on mask patterns for coded-mask imaging. Dr Dimitrios Psaltis of Arizona University has collaborated with researchers at SU on disk oscillations. We ask all visitors to give talks in central Istanbul so that all Turkish astronomers can benefit from their experience.

Expert visits constitute one part of the transfer of knowledge. The other part is through staff member and student visits to the partner institutes. So far, these have led to collaborations being established on a number of small scale projects. Examples of these projects include; work on XMM-Newton energy calibration (MPE), magnetar atmosphere models (Amsterdam), ray tracing simulations for Si pore detectors (Leicester), CdZnTe detector characterisation (DTU-Space), high speed optical observations of neutron stars (Crete, MPE), optical spectra of neutron star binaries (Crete) as well as research on high-time resolution instrumentation on XEUS (CESR). In addition, a postdoctoral researcher funded by the ASTRONS project, Dr Trevor Sidery (PhD 2007, University of Southampton) works on the inner structure of neutron stars, and we expect to hire another researcher very soon.

We have been organising annual international meetings, called the ‘ASTRONS Workshops’ in Instanbul to disseminate knowledge on the wide range of neutron star instrumentation activities. These workshops provide an excellent environment to all Turkish high energy astrophysicists to keep up with the latest developments in the field and interact with distinguished participants. With the help of ASTRONS, we encourage and support the attendance of all Turkish PhD students and young researchers at these meetings.

Of course knowledge transfer is very much a two-way process. Even though SU researchers acquire a lot of knowledge from workshops and meetings, we also feed our knowledge back to the community in areas where we hold expertise. Researcher visits and workshops are particularly important in this regard. Our group is especially strong in the studies of neutron star interiors and dynamics, as well as fallback disks around isolated neutron stars, knowledge we are keen to disseminate to a wider base of researchers.

Case Studies
- Spectral investigations of magnetar atmospheres provide a clear example of how two-way knowledge transfer works. Magnetars are isolated neutron stars that are believed to possess the strongest magnetic fields in the Universe. ASTRONS researchers have, for the first time in the field of magnetar spectral studies, developed a numerical model that incorporates both atmospheric and magnetospheric processes affecting the emergent X-ray emission from the stellar system. They have applied the developed model to X-ray data collected with ESA’s XMM-Newton and obtained perfect representations of the X-ray data, and thus have been able to deduce the magnetic field strength of the neutron star directly from X-ray spectral observations. Dr Feryal Özel (University of Arizona), Dr Tolga Güver (Istanbul University/University of Arizona), Dr Ersin Göðüþ (Sabanci University).

- Development of the high energy astrophysics instrumentation lab at Sabanci. This project has involved close collaboration between SU, DTU-Space and Leicester. SU provided the initial funding, while ASTRONS has, through visits to and from DTU-Space and Leicester, been providing knowledge transfer in the field of semi-conductor detectors and coded mask imaging. The lab is almost operational now. Moreover, the international nature of the collaboration has helped us obtain more funding from the Technological and Scientific Research Council of Turkey so as to develop a space born detector system to be utilised on a Turkish satellite. Dr Emrah Kalemcı (Sabanci University) is in charge of these efforts.

The ASTRONS project has provided great opportunities for Turkish astronomers to develop their knowledge in the field of neutron star research and instrumentation. We will continue to benefit from the close links we have established with other institutes, even after ASTRONS is over, and hence we will be ready to tackle the lingering questions of neutron star interiors and exteriors in the IXO era. ★

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**At a glance**

**Full Project Title**
Astrophysics of Neutron Stars (ASTRONS)

**Project Partners**
Sabanci University – Turkey (coordinator)
University of Amsterdam – The Netherlands
University of Leicester – The United Kingdom
Max-Planck Institut für Extraterrestrische Physik (MPE) – Germany
Max-Planck Institut für Astrophysik (MPA) – Germany
Centre d’Etude Spatial des Rayonnements (CESR) – France
Danish National Space Center, DTU Space – Denmark
University of Crete – Greece
University of Warwick – The United Kingdom

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**Prof M. Ali Alpar**
Principal Investigator, Sabanci University

Dr M. Ali Alpar (member, Turkish Academy of Sciences) has a BS in Physics (1972) from Middle East Technical University (METU), Ankara, Turkey, and a PhD from the University of Cambridge. He worked at Columbia University, University of Illinois in Urbana-Champaign, Bogazici University, METU, and TUBITAK. He is currently Director of the Foundations Development Programme at Sabanci University (SU) and Chairman of the Turkish Astronomical Society.
The demographic profile of the developed world has changed significantly over recent years, and the proportion of older people in the wider population continues to grow. This is a trend which makes the development of more effective healthcare solutions, particularly in neurology, a real priority. The importance of this work is further reinforced by the fact that neurological diseases like Alzheimer’s impose significant financial and emotional costs on society – estimated at ~139 bn per year in Europe alone. This figure does not even take into account the effects of the early stages of the disease, the emotional pain caused to the family, and the economic impact of the loss of experienced people from the workforce.

Early, objective detection is essential if we are to alleviate, or possibly even prevent, neurological diseases. However, this requires the ability to not only automatically quantify biomarkers that will help distinguish the healthy from the affected, but also to identify the most relevant biomarkers for individuals according to their diagnoses. It is also important to develop computerised means to help the experts make confident decisions independent of their own levels of experience, not to mention their own levels of mental and physical alertness. To this effect, we in the IRonDB (MR-based Analysis, Indexing, and Retrieval of Brain Iron Deposition in Basal Ganglia) project are offering a unified solution centred on indexing, search and retrieval technology.

One of the most interesting biomarkers, one that is relevant to a number of neurodegenerative diseases, is the amount...
of iron to have accumulated in the basal ganglia of the brain. Iron starts to accumulate in the brain as part of aging, but some people have accumulated abnormal amounts, which is of great interest to our project. Abnormal accumulation is suspected to relate to oxidative stress that can disrupt normal brain functioning. Tissues with high iron concentration appear hypo-intense (darker than usual) in the T2 contrast of MR images; hence, a non-invasive indirect measurement is possible.

We in the IRonDB project started our work with the iron-related MR T2 darkening as our first biomarker (hence the name of the project), and investigated whether the pattern of the iron accumulation was a stronger marker than just the cumulative load, which is what clinical experts and researchers usually use. We have shown, in various experiments, the clinical benefit of using patterns of iron accumulation.

Automated methods make it possible to extract biomarkers consistently for a large number of patients, which can be used to inform future treatment. Past cases hold great relevance to the treatment of a patient that a doctor is faced with at a given time and, compared to the rest, the groups identified by a biomarker may also share a similar disease progression. Using expert feedback to find similar sets, and engaging in computerised reasoning based on that feedback, will allow us to improve the diagnostic quality of a decision support system. We envision a powerful content-based indexing, search and retrieval system centred around the biomarkers. A search and retrieval system is also able to meet users' specific information needs by referring back to the user's markings on their returns to a specific query, hence providing only the most relevant information. The system's ability to engage in online adaptation of the results to meet the user's requirements is of great importance. In this way the expert is still in charge and can guide the process by his knowledge, while the system itself can select the most relevant biomarkers automatically.

Neurologists and radiologists have to take multiple considerations into account in making a diagnostic decision. As a result, it is unlikely that hypo-intensity on its own will be able to meet clinical needs. Since the start of the project we have consulted frequently with the clinical experts in various hospitals, and further have expanded the scope of the project to include different image-based features that the experts use, or that may have the potential to be biomarkers in other neurological diseases. Furthermore, because a number of other brain structures outside basal ganglia are also important, the segmentation of different structures is critical to the broad clinical impact of our tool.

The technical workload in the IRonDB project is borne mainly by three full-time fellows at the post-doc level: Devrim Unay adds expertise in automatic biomarker extraction, including hypo-intensity and texture, biomarker description, and search and retrieval. He has built the first prototype system of IRonDB. Meanwhile Octavian Soldea is at Sabanci University and is primarily responsible for brain structure segmentation, but is also the main contributor to the advanced visualisation tools. Ceyhun Burak Akgul provides valuable knowledge on 3D shape description and relevance feedback. In addition to their close collaboration with each other, the three fellows also closely interact with professors Aytul Ercil and Mujdat Cetin at Sabanci University, and the senior researchers Ahmet Ekin and Radu Jasinschi at Philips Research.

At a glance

**Full Project Title**
MR-based Analysis, Indexing, and Retrieval of Brain Iron Deposition in Basal Ganglia (IRonDB)

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Dr Ahmet Ekin [left]
Prof Aytul Ercil (Co-PI) [right]

**At a glance**

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Dr Ahmet Ekin [left]
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Bimanual Rehabilitation System for Distal Upper Extremity Therapy

The use of robotic devices brings many benefits to the field of physical therapy. Rehabilitation exercises are repetitive and physically challenging, strains which can be significantly reduced by the use of robotic devices. Not only do they help eliminate the physical burden of movement therapy for the therapists themselves, but their increased use also reduces application-related costs. Moreover, robot-mediated rehabilitation therapy allows quantitative measurements of patient progress and can be used to realise new treatment protocols. In the REHAB-DUET (Bimanual Rehabilitation System for Distal Upper Extremity Therapy) project, our goal is to develop a novel rehabilitation system for patients who have suffered neurological injuries that affect the control of their upper extremities, specifically their forearm and wrist movements.

Although the beneficial effects of robot-assisted rehabilitation over conventional therapy have been demonstrated through clinical trials, it has not yet achieved the success which was initially expected. This is largely because existing robot-assisted rehabilitation systems use human-machine interfaces that do not allow for the active involvement of patients. Specifically, many of the existing devices employ robots as non-accommodating trajectory generators, while the patients are expected to behave as passive subjects. Even though such passive paradigms are effective in treating secondary concerns such as muscle weakness, they are unable to properly address the primary goal of physical therapy for neurological injuries – encouraging plastic recovery of neural control systems in the brain and the spinal cord.

The REHAB-DUET project takes a different approach to robotic-assisted physical therapy. Emphasising the importance of the active involvement of patients in the physical therapy routine, we propose a bimanual rehabilitation system with assistance methods that allow patients to practice self-induced robotic therapy through the use of their intact arms. We have designed therapeutic, wearable force-feedback devices (powered exoskeletons) and bilateral control paradigms for this bimanual rehabilitation system, so that patients can guide and control the physical assistance being provided to their injured extremity using their intact arm. In this system, the exoskeleton that actuates the injured arm constitutes the slave device, which itself is driven by reference commands received from the master device guided by the intact extremity.

During physical therapy, patients drive the master interface to elicit forces from the slave device so as to provide mechanical assistance to the impaired arm and to achieve coordinated movement. Furthermore, patients can also control the amount and duration of mechanical assistance provided during therapy. The active involvement of patients in the rehabilitation process helps them retain control of the centres of their brain and those parts of the spinal cord dedicated to their injured extremity, thus stimulating improved motor recovery through activity-dependent plasticity.

The cutting edge of research

The REHAB-DUET project is at the cutting edge of studies on bimanual rehabilitation devices. Promoting the active involvement of patients, the project has the potential to have a profound and lasting influence on the way rehabilitation therapies are delivered, and further to revolutionise current healthcare methodologies. The proposed approach to robot-assisted therapy may even lead to a significant decrease in healthcare expenditure and also help strengthen the European economy by prolonging the active participation of these individuals in society. Not only that, but it will also help reduce treatment costs by virtue of the enhanced effectiveness of the therapy. It is hoped that the project will eventually help millions of those patients suffering from secondary disabilities related to neurological problems, across Europe and indeed the globe, to gain functional independence, in the process drastically improving their welfare. This is an objective very much in Europe’s economic, social and medical best interests.

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Volkan Patoglu worked as a post doctoral research fellow in Haptix Laboratory at the University of Michigan and as a post doctoral research associate in Mechatronics and Haptic Interfaces Laboratory at Rice University. Currently, he is an assistant professor in the Faculty of Engineering and Natural Sciences at Sabanci University.
As two of the world’s main cereals, wheat and barley form an important part of the global diet, and ensuring the long-term sustainability of their production is thus an economic priority for many governments. However, the continued growth of the world population is placing great pressure on farmers to boost production levels, while changing global weather patterns add another layer of complexity for producers to negotiate. These twin issues pose a real challenge to those charged with growing these two enormously important crops, which are used to make staple foods like pasta and noodles, not to mention their central role in the production of both alcohol and biofuels.

In this context work to sequence the wheat genome (which in itself is five times the size of the human genome) takes on enormous importance. A technically complex objective, work to sequence the wheat genome demands broad-based collaboration, something which has been widely recognised. As such research into the issue will be conducted by an international consortium, the IWGSC (International Wheat Genome Sequencing Consortium), which was established in 2005 so as to facilitate and coordinate international efforts to obtain the complete sequence of the bread wheat genome. With bread wheat accounting for over 95 per cent of the overall global wheat growing area, the potential impact of this work cannot be overstated.

This is work in which the TriticeaeGenome project (Coordinated by Catherine Feuillet, INRA), by bringing together some of Europe’s top laboratories to advance research into wheat and barley, is playing a key role. Wheat and barley are two of the most important cereals currently being grown in Europe, and TriticeaeGenome’s research is aimed at encouraging the development of new varieties of these crucial crops. Specifically, the TriticeaeGenome project aims to develop genomic tools and to isolate genes from the group 1 and 3 chromosomes in wheat and barley. The project will contribute further to international research efforts, which thus far have focused (in wheat) on chromosomes of group 3 in France and in the USA. The overall goal is to improve cereal breeding using the map-based isolation of a number of those genes of agricultural interest that have been identified in common wheat (bread wheat), and that will thus set the stage for future sequencing of the genome.

The sequencing of the wheat genome will contribute to an improved understanding of the biology of wheat. This has a number of implications: it will enable yield and end-use quality improvements, both of which are crucially important if we are to meet the challenge of feeding the world’s growing population in a sustainable, environmentally-sound manner. We live in a world on the verge of major climate and sociological changes, which means advanced, innovative scientific research is a must if we are to deal effectively with emerging issues. By conducting comparative genomics studies between wheat and barley the TriticeaeGenome project will elucidate the evolutionary forces driving speciation, and hence help Europe adapt to evolving circumstances.

For five years, he has been leading the project secured from EU-Marie Curie International Grant, and has been involved in Harvest Plus. He has also received two national grants from TUBITAK (The Scientific and Technical Research Council of Turkey) and is in the management committee of the COST action FA0604.