The Multidisciplinar Centre for Astrophysics (CENTRA) is a scientific research centre in IST, with a team in Universidade do Algarve (UAlg) and collaborators at the Universidade da Beira Interior (UBI). The team comprehends a permanent core of more than 15 doctorate researchers, working with portuguese and foreign scientists as visiting or post doctoral research fellows, and also Ph.D., Masters and finalist undergraduate students.

The main scientific areas of CENTRA are Theoretical Physics (Theoretical Astrophysics and Cosmology, Fundamental Physics, High Energy Physics) and Observational Astrophysics (Observational Cosmology and Solar and Stellar evolution). A strong commitment in the development of these areas and the establishment of interchanges and cooperations with international research centres has been CENTRA's strategy. Worth of mention are the collaborations with the Universities of Aveiro, Coimbra, Lisbon and Oporto, Paris VI and VII, Stockholm, Berkeley (California), Columbia (New York), Mississippi, Indiana (USA), Oxford, University of Santiago de Compostela, Rio de Janeiro National Observatory and Moscow State University.

The main objective of CENTRA is to have a solid theoretical understanding of a vast physical phenomena as a means to interpret observations. These observations may refer to the very small, where we try to make sense of data from particle accelerators, cosmic rays and conceptual problems in physics. Interesting observational data concerns the very large, gravitational waves from massive binaries or from the early universe. Still on large scales, supernovae studies allow the determination of the cosmological parameters that control at different stages, the evolution of the Universe. In a curious interplay, theory and experiment often meet, and the physics of the very large need a tight control on the physics of the very small, which is where CENTRA's strength lies: its multi-disciplinarity.

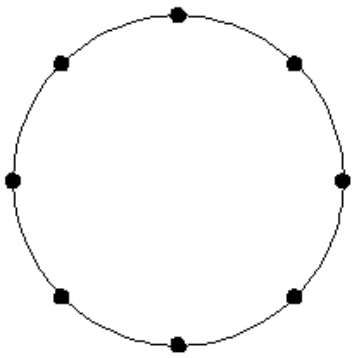
If you want to learn more about us, contact us or show up here, we are glad to give you a tour of CENTRA's facilities.

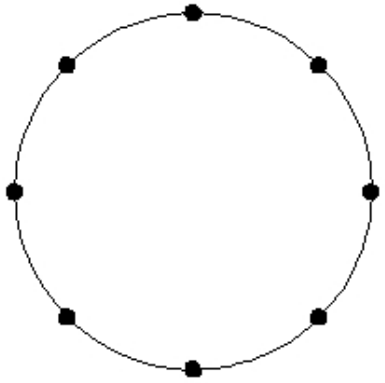
The theory group of CENTRA is very young and internationally competitive. We regularly publish on major scientific journals. A large number of collaborations with colleagues

throughout the world has widen our research interests and impact of our publications . The theory group of CENTRA is focused on the following topics.

Theoretical Astrophysics and Cosmology

One of the most exciting topics in physics in recent years concerns gravitational waves, their fundamental properties and what one can learn from them. Gravitational waves are an old prediction by Einstein in 1916 but were never directly observed. A huge effort is now ongoing to see the effect of these waves on Earth-based detectors, such as LIGO. These effects, exemplified in the figures below for the two different kinds of polarizations, is very tiny. Typically a gravitational wave induces a displacement smaller than the size of an atom!





Fundamental Physics

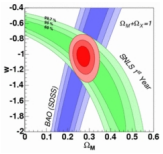
On small scales, String theory has made remarkable progress in the last decades and has given us an important legacy: the AdS/CFT correspondence. This correspondence, mapping gravitational physics in anti-de Sitter backgrounds to fieldt theories on the boundary of those spacetimes, is very efficient. With this correspondence one is now studying QCD using gravity, and even the physics of heavy ion colliders may be described this way. At CENTRA, the theory group is using this correspondence in a number of ways. The first and more fundamental way is to understand

black holes in this setting. It is known that they represent thermal states in the dual field theory, but the dynamics of black holes in anti-de Sitter space are not so well understood. We have now started a long-term project aimed at exploring this aspect. This will likely require the use of numerical simulations to fully understand black holes in anti-de Sitter.

High Energy Physics

Saturation models in QCD, high energy CR, Physics in Auger and LHC

The work of the Observational Astrophysics Group was divided into two main areas: Cosmology with Supernovae (SNe), cosmic microwave background (CMB) and 21 cm experiments; Sun-Earth Interaction (SEI) and stellar evolution. The objectives were:



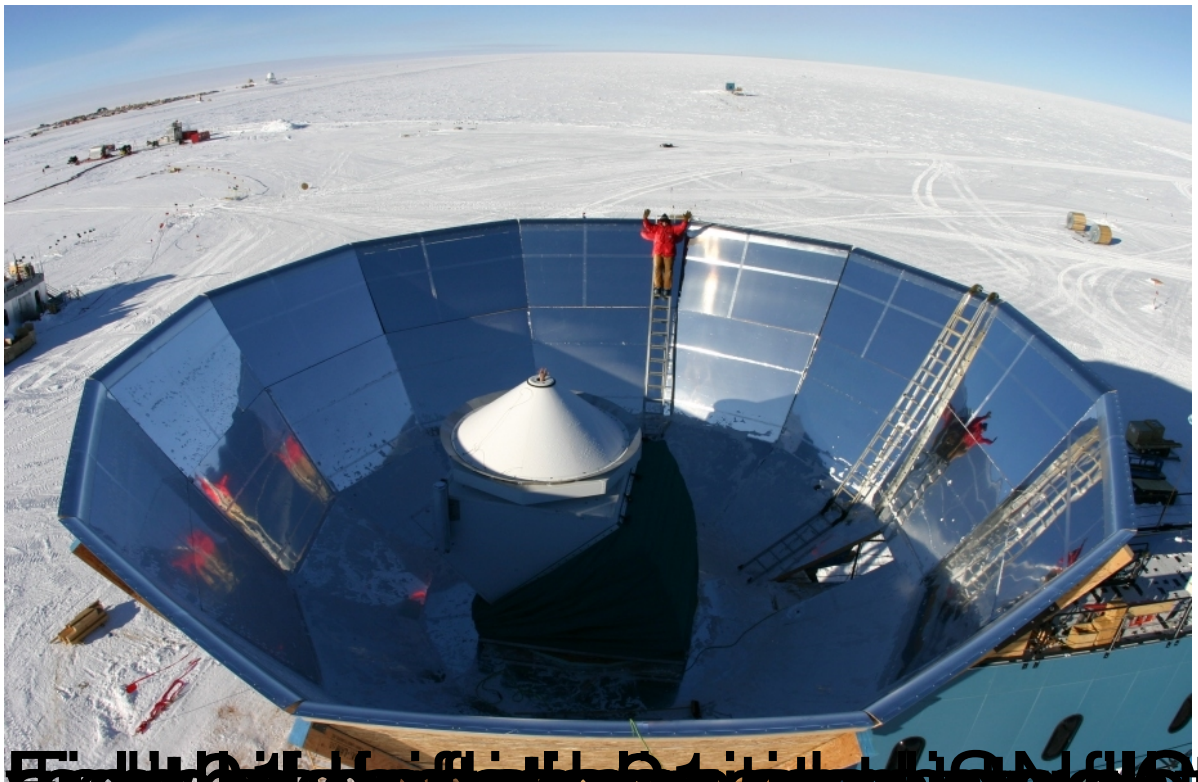
Cosmology with SNE, CMB and 21 cm experiments:

Second generation SNe surveys started in 2002, with the purpose of determining the nature of dark energy. Our group joined the Supernova Legacy Survey (SNLS), a 5-year international project to detect and study 200 SNe using the Canada-France-Hawaii telescope.Our objective was to

participate in SNe detection, data reduction and software development. SNe studies in the context of the Supernova Cosmology Project were also to be continued. The determination of systematic errors contaminating SN studies was a main goal.

Obscuring our view of the CMB and 21 cm experiments are extragalactic and galactic foregrounds. CENTRA planned to install in Portugal a radio telescope similar to the GEM-Galactic Emission Mapping, to map the polarized synchrotron radiation in the frequency range 2-15 GHz. This northern hemisphere survey would match southern hemisphere surveys to produce high quality sky maps. GEM is now considered as an ancillary

experiment to Planck Surveyor.



SEI and stellar evolution

In an ever more technologically dependent world, the field of space weather forecasting is

increasingly important, although it is still far from the Earth-based standards. One of the main areas of interest in this field is the evolution of te Sun, which is also at the heart of our research. We pursue work in this field with solar seismology and astereoseismology, which have already shown their ability to probe the solar

interior.

New layer...