XXIII Trobades científiques de la Mediterrània

Supernovae: light in the darkness

Maó (Menorca) 3-5 October, 2007

Abstracts

Deborah AGUILERA
Title:
Joule heating governing the cooling of magnetized neutron stars

Abstract:
We study the thermal evolution of neutron stars with strong magnetic fields (B > 1e13 G). We solve the diffusion equation with axial symmetry and obtain the 2D thermal evolution of magnetized neutron stars. We include the state of the art of the microphysics that controls the cooling as slow/fast neutrino processes, superfluidity, as well as possible heating mechanisms. We discuss the magnetic field decay and Joule heating that influence and even controls the cooling of strongly magnetized neutron stars, such as magnetars. We characterize the temperature anisotropy induced by the magnetic field and make predictions for the early and late stages of the evolution of isolated neutron stars.The results are compared with available data on temperature, magnetic field and ages of INSs, AXPs, SGRs and PRSs.

Anna ARTIGAS
Title:
The role of Supernovae in Galaxy evolution

Abstract:
We use an SPH code with star formation, feedback from supernovae and chemical enrichment implemented in order to study galactic evolution. Using simulations of individual galaxies, we show how the supernovae explosions produce either galactic fountains or outflows, depending on the depth of the gravitational potential. In low-mass haloes, supernovae can greatly supress the overall efficiency of star formation. We also study how the explosions of massive stars enrich the surrounding gas with metals.

Carles BADENES
Title:
The Persistence of Memory, or How the X-ray Spectra of Type Ia Supernova Remnants Reveal the Brightness of their Parent Supernovae

Abstract:
Recent advances in our understanding of the X-ray spectra of Type Ia Supernova Remnants (SNRs) allow us to use these objects to estimate the brightness of their parent supernovae (SNe). I will discuss the examples of Tycho and 0509-67.5 in the LMC. This last object is specially interesting given the recent results on the spectroscopy of its light echo. In the context of the mounting evidence that dim and bright Type Ia SNe might come from different kinds of progenitors, these SNR studies open new possibilities to investigate the local environments where these progenitors arise.

Maria Teresa BOTTICELLA
Title:
STRESS a SN survey at ESO

Abstract:

To measure the Supernova rates at intermediate redshift we performed the Southern inTermediate Redshift ESO Supernova Search (STRESS). Unlike most of current Supernova searches, this survey was specifically designed to estimate the rate for both of Type Ia and Core Collapse Supernovae. We followed an approach in the Supernova rate measurement that allows us to explore the properties of the monitored galaxies and to link them to Supernova rates.
Essentially we selected a galaxy sample instead of considering the total volume surveyed and measured Supernova rate per unity B band luminosity. Moreover this approach simplifies the comparison of the intermediate redshift rate measurements with the local ones. Our analysis is based on a sample of 40000 galaxies and on the 26 spectroscopically confirmed Supernovae plus 64 reliable Supernova candidates detected monitoring our galaxy sample for about five years.
Our results per unity B luminosity indicate that the Core Collapse Supernova rate increases at intermediate redshift with respect to local estimate of a factor about 2 whereas the Type Ia Supernova rate remains almost constant. We also measured the type Ia and Core Collapse Supernova rate in the “red” and “blue” galaxy sub-samples. The observed trend of Supernova rates from “red” to “blue” galaxies at intermediate redshift is similar to that in the local Universe.

Eduard BRAVO

Title:
Do thermonuclear supernovae dwell in the three-dimensional space?

Ruben CABEZÓN
Title:
Gravitational waves as tracers of nuclear equation of state.

Abstract:
The signal of neutron star (NS) mergers has the imprint of the EOS of dense nuclear matter, which is still not well known. A set of gravitational waves (GW) signals have been calculated from 3D hydrodynamical simulations of NS-NS mergers using the Smooth Particle Hydrodynamics technique (SPH) with different EOS. By analyzing the morphology and time evolution of the signal we want to be able to discriminate between all the range of EOS after a successful GW detection has been done. Several examples confirming the feasibility of the previous idea will be given.

Judit CAMACHO
Title:
Monte Carlo simulations of the Galactic binary population

Abstract:

We present a detailed Monte Carlo simulator of the population of binary stars within the solar neighborhood. We have used the most updated models for stellar evolution from Hurley et al. (2000), a complete treatment of the Roche lobe overflow episodes, as well as a full implementation of the orbital evolution. Special emphasis has been placed on processes leading to the formation of binary systems in which one of the members is a white dwarf. As a preliminary application of our Monte Carlo simulator we have

performed a statistical study of the scenarios leading to Type Ib supernovae events within our Galaxy

Sílvia CATALÁN
Title:
WD0433+270: an old Hyades stream member or an iron-core white dwarf?

Abstract:
G39-27/289 is a common proper motion pair formed by a white dwarf (WD0433+270) and a main-sequence star (BD+26 730) that apparently has been classified as a member of the Hyades open cluster. Previous studies of the white dwarf component yielded a cooling time of 4 Gyr aprox. considering the typical C/O core composition. although it has not been pointed out before explicitly, this result is 6 times larger than the age of the Hyades cluster, giving rise to an apparent conflict between the physics of white dwarfs and cluster main-sequence fitting. In this poster we present the spectroscopic and kinematic analysis of the members of this system. According to our results, we distinguish two plausible scenarios. First, if the pair does not belong to the Hyades cluster but only to the Hyades stream, this would indicate that such stream contains objects of rather old age and definitely not coeval with the cluster. This has interesting consequences for Galactic dynamics. The second and our favoured scenario is that of a white dwarf with a rather exotic iron core, having a cooling time compatible with the Hyades age. This is a tantalizing result that would have implications for white dwarf formation models and degenerate nuclei explosion theories.

Inma DOMÍNGUEZ
Title:
Precision of thermonuclear supernovae as distance indicators

Abstract:
Observations of thermonuclear supernovae at high-z show that most of the Universe is Dark Energy, characterized by its negative pressure. SNIa Hubble Diagrams, including nowadays 200 of these objects up to z=1.8, strongly favours a Universe with deceleration at z>0.5 and recent acceleration. Taken all current data together (SNIa, CMB, BAO and Large Scale Structure) the fraction of the dark energy to the critical density is 70% and its EOS is compatible with the cosmological constant or vacuum energy. However, any further attempt to characterize this EOS based on Sne Ia requires to decrease the present scatter in the Hubble Diagram by a factor of 10. Ultimately, systematic effects, like extinction and evolution with z, and uncontrolled intrinsic dispersion of the light curve shapes will limit the precision by which SNe Ia could be used to measure Cosmology. Moreover, observations indicate that brighter SNIa occur only in systems with ongoing star formation and that the majority of SNe Ia comes from young progenitors. In this work we focus on the scatter of the maximum luminosity of SNe Ia due to the potential range of the following properties related to the progenitors: (a) mass and metallicity of the progenitor of the exploding white dwarf, (b) rotational velocity in the context of the merging of two WDs and (c) explosive ignition density.

Nancy ELIAS
Title:

DUST ALONG THE Sne LINES-OF-SIGHT

Abstract:
The determination of the extinction in different directions in the Galaxy and in external galaxies is of paramount importance in several fields ofastrophysics. The determination of the extinction law provides clues on the nature of the Interstellar Medium (ISM), in particular, on the dust particles. Recent studies have shown that the extinction curves toward a few, highly-reddened SNIa have values of Rv significantly lower than the canonical 3.1. Whether this is the case only for highly extinguished objects is not clear yet. It will be extremely important both for understanding the ambient in which is embedded the exploding stars and for the calibration of SNe Ia for cosmological use. Thus, and in the context of our present knowledge of dust properties, we will discuss the information that we can obtain from the studies of these highly extinguished SNe Ia, i.e. the possibility of deriving the average size of the dust grains along their lines-of-sight and study the behaviour of the NaID absorptions line in the SNe.

Ramon FORCADA
Title:
Edge-lit double detonation in Subchandrasekhar-mass models for Type Ia supernovae

Abstract:
The explosion of a helium layer accreted on top of a white dwarf, leading to the subsequent explosion of the whole star (while the accreting dwarf is still below the Chandrasekhar mass) might be an alternative model for some Type Ia supernova explosions. In this communication we present several two-dimensional hydrodynamic calculations concerning these models. The usual assumption for this type of scenario is that the helium shell detonates first, and the detonation propagates across the helium layer leading to an off-center detonation of the underlying carbon at the ntipodes after a while. In contrast, we also explore the feasibility of a slightly different mechanism: in systems with higher densities at the interphase between the white dwarf and the accreted material, the initial helium hot spot might prompt the detonation of the carbon lying just underneath. To this end, we provide a detailed discussion on this mechanism and its consequences to Subchandrasekhar mass models of Type Ia supernovae.

Pilar GIL
Title:
Is there a chance for primordial SNeI1/2?

Abstract:
The evolution of primordial stars of initial masses between 5 and 10 Ms has been computed and analysed in order to determine the nature of the remnants of massive intermediate-mass primordial stars and to check the influence of overshooting in their evolution. We have obtained the values for the limiting masses of Population III progenitor stars leading to carbon-oxygen and oxygen-neon compact cores. We have also obtained the limiting mass for which isolated primordial stars would lead to core-collapse supernovae after the end of the main central burning phases. Considering a moderate amount of overshooting, the mass thresholds at the ZAMS for the formation of carbon-oxygen and oxygen-neon degenerate cores shift to smaller values by about 2 Ms. As a by-product of our calculations, we have also obtained the structure and composition profiles of the resulting compact remnants. We find that the final fate of the considered stars could not be to become white dwarfs, as it is the case of higher

metallicity objects of analogous initial masses. Instead, as we show by means of a basic synthetic code, they might end their lives as SNI1/2.

Margarida HERNANZ
Title:
Accreting white dwarf

Abstract:
Thermonuclear (type Ia) supernovae are explosions in accreting white dwarfs, but the exact scenario leading to these explosion is still unclear. An important step to clarify this point is to understand the behaviour of accreting white dwarfs in close binary systems. The characteristics of the white dwarf (mass, chemical composition, luminosity) and those of the accreted material (composition, accretion rate), related with the properties of the binary system, are crucial for the further evolution towards the explosion. An analysis of the outcome of accretion and the implications for the growth of the white dwarf towards the Chandrasekhar mass and its thermonuclear explosion will be presented, as well as alternative scenarios with a sub Chandrasekahr mass white dwarf.

Alina HIRSCHMANN
Title:
Gamma-ray Photons and Positrons from Type Ia Supernovae

Abstract:
The explosion mechanisms of Type Ia Supernovae (SNIa) are still a matter of debate. These events occur when a white dwarf, belonging to a binary system, accretes enough mass from its companion star and reaches the Chandrasekhar mass limit. Many theoretical approaches have been proposed although, unfortunately, there are no observations sensitive enough to confirm or refute the various scenarios selected up to now. Gamma-ray emission from these events would allow unique information on the explosion mechanisms since the emitted high energy photons are produced by the decay of radioactive elements, which in turn are generated when the shock wave and incinerating front, produced from the explosion, pass through the entire star. The properties of these radioactive elements provide robust information on the internal structure of the star and the possible reasons of the explosion, which depend on the progenitor system. We present simulations, in the gamma-ray range, achieved by a 1D and 3DMonte Carlo code using a considereable set of theoretical models. We analyze the positron and photon transport and behavior within the expanding ejecta and provide considerable theoretical information for later comparison with observations. The observations will be obtained using gamma ray satellites such as ESA's Integral, of which we have been granted with observation time in the midst of having such event take place at fairly close distances.

Hans-Thomas JANKA
Title:
Core-Collapse Supernovae: Recent Progress in Explosion Modeling

Abstract:
The talk will review the current status of modeling stellar core collapse and supernova explosions. It will describe recent developments in our understanding of the explosion

mechanism based on new multi-dimensional hydrodynamic simulations. While stars near the probable low-mass end of supernova progenitors (around roughly nine solar masses) are found to explode robustly by the neutrino-heating mechanism, the current models still yield controversial results about how considerably more massive stars achieve to explode. A critical assessment of the viability of different suggestions for the explosion mechanism will be given. Observational constraints coming from heavy-element nucleosynthesis, explosion asymmetries, and pulsar kicks will be addressed, and how recent models have made progress in accounting for them.

Raul JIMÉNEZ
Title:
Evidence for short-lived SN Ia progenitors

Abstract:
The standardization of SNIa as standard candles is still largely empirical and may be affected by as-yet unexplored effects evolving with redshift. A systematic effect of 1--2\% in the peak luminosity correlated with redshift is not excluded by current observations, and could be degenerate with cosmological parameters jeopardizing the measurement of the parameters of the dark energy equation of state as planned by the Joint Dark Energy Mission (JDEM). A crucial issue is of course metallicity, which evolves with redshift. There have also been indications for a diversity of delay times between epochs of star formation in the host galaxy and the supernova explosion itself, which would imply a progenitor population evolution between high and low redshift supernovae. As a first step toward modeling the effect of progenitor properties on the SNIa luminosities and the stellar evolution paths leading to a supernova explosion, we determine, by modeling the host spectra with stellar population models, delay times from a sample of 257 SNIa host galaxies with spectra in the SDSS-DR5. We show evidence (at more than 5σsignificance) for a short (less than 70 Myr) delay time component in the SNIa population, which is distinct from a long delay time of a few Gyr.

Pablo LOREN
Title:
High resolution SPH simulations of merging white dwarfs binary systems

Abstract:
We present the results of a series of three-dimensional, high resolution SPH simulations of the merging of binary white dwarfs. We have followed the chemical and hydrodynamical evolution of the systems. Also its gravitational wave emission has been estimated, in order to ascertain if the signal will be strong enough for a direct detection of LISA.

Katarzyna MALEK
Title:
Pi of the Sky

Abstract:
I describe "Pi of the Sky" project - experiment designed for the continuous observation of large part of the sky in search for optical afterglows associated with gamma ray burst (GRB) and other short optical transients. The apparatus consists of two arrays, working in coincidence mode, 16 CCD cameras each. The whole system continuously observes

2 steradians of the sky with a time resolution of order of 10 seconds. The whole system is currently in an advanced stage of construction. Required hardware and software tests were performed with a prototype – two cameras working in coincidence, located in Las Campanas, Chile. Pi of the Sky" automatic triggers system has detected bright flares (for example CN Leo, GJ 3331A / GJ 3332), cataclysmic variables, some spectacular meteor explosions and others significant events.

Marc RIBÓ
Title:
Very-High-Energy observations of X-ray binaries

Abstract:
The new generation of imaging atmospheric Cherenkov telescopes (HESS, MAGIC, VERITAS) has allowed to conduct sensitive observations in the TeV regime. Several X-ray binaries have been detected, among them PSRB1259-63, LS5039, LSI+61303 and very recently Cygnus X-1. All of them contain high-mass donors. While in the case of PSRB1259-63 the compact object is a confirmed young non-accreting pulsar, and in the case of Cygnus X-1 is a dynamically confirmed stellar-mass black hole and microquasar jet source, the situation is not yet clear in the cases of LS5039 and LSI +61303. I will summarize the current status of Very-High-Energy observations of X-ray binaries and discuss possible scenarios that have been put forward to explain the TeV emission of these systems.

Fritz ROEPKE
Title:
Thermonuclear Supernovae

Abstract:
The application of Type Ia supernovae (SNe Ia) as distance indicators in cosmology calls for a sound understanding of these objects. Recent years have seen a brisk development of astrophysical models which explain these events as thermonuclear explosions of white dwarf stars. While the evolution of the progenitor is still uncertain, the explosion mechanism certainly involves the propagation of a thermonuclear flame through the white dwarf star. Three-dimensional hydrodynamical simulations allowed to study a wide variety of possibilities involving subsonic flame propagation (deflagrations), flames accelerated by turbulence and supersonic detonations. These possibilities lead to a variety of scenarios. I will review the currently discussed approaches and present some recent results of the Garching SN Ia modeling group.

Alicia SINTES
Title:
Gravitational wave astronomy: now and future

Abstract:
After years of commissioning and increasingly more sensitive science runs, gravitational wave detectors have reached their first-stage design sensitivity and are now operating full-time. Data sharing agreements among LIGO, GEO and Virgo also make a reality that gravitational wave detectors will be operated as an integrated network. In this talk I will survey the state of the various detectors and the prospects for the future, including the plans for advanced and third generation ground-based

detectors, as well as the LISA mission. I will also review the way the data are being analyzed, and the impact of gravitational wave observations on astrophysics, cosmology and fundamental physics. To date, no claim of detection has been yet made. However, upper limit measurements, inferred from these null results, are beginning to probe potentially interesting regions of the space of parameters of astrophysical signals and source population models.

Carlos SOPUERTA
Title:
Gravitational Radiation from Neutron Stars and Black Holes

Abstract:
We will discuss several mechanisms in which neutron stars and black holes, individually and in binary systems, can produce detectable gravitational-wave emissions, and what (astro)physical information can be extracted from the detection and analysis of this radiation. In particular, we will consider the possibility that nonlinear effects arising from the coupling between radial and non-radial oscillations of neutron stars may produce distinctive gravitational-wave signatures, and we will discuss the case of neutron star-black hole binaries.

Moisès SUADES, Margarida HERNANZ, Nicolas de SÉRÉVILLE
Title:
Galactic 26Al, 60Fe and 60Fe/26Al gamma-ray flux ratio from massive stars

Abstract:
Massive stars are responsible for the synthesis of radioactive isotopes which decay leading to gamma-ray line emission. We will focus our analysis on 26Al and 60Fe, two gamma ray emitters with about 1 Myr half life, small enough to be detected, but still large enough to present diffuse emission. The detection of the line at 1.809 MeV from 26Al and the two at 1.173 MeV and 1.333 MeV from 60Fe has provided a proof of their on-going nucleosynthesis in our Galaxy. We aim to determine the theoretical 60Fe/26Al flux ratio, as well as to evaluate the global 26Al and 60Fe content in the Galaxy. A comparison between our theoretical flux ratio and the value obtained from the latest observations of RHESSI and INTEGRAL satellites leads us to reconsider the basis of our study by taking into account the high metallicities of the massive stars progenitors. There is still a discrepance between theory and observations of the flux ratio, and a small 26Al and 60Fe galactic content is obtained, which indicates that more work has to be done in order to obtain reallistic yields for high metallicities.

Vincent TATISCHEFF
Title:
Cosmic-ray acceleration in supernova remnants

Abstract:
Supernova remnants (SNRs) are thought to be a major source of cosmic rays in the Galaxy. Observations of radio and X-ray synchrotron radiation attest that electrons are efficiently accelerated at the blast wave. Recent observations of TeV gamma-rays from shell-type SNRs confirm the production of highly relativistic particles in several objects, but there remains considerable debate as to wether this emission originates from fast

electrons or ions. The dynamical properties of several remnants point however to efficient acceleration of ions. I will discuss the theory of diffusive shock acceleration in SNRs in the light of these observations

Eli WAXMAN
Title:
Gamma-ray bursts: Some open questions

Abstract:
Observations of long- and short-term "afterglows" of gamma-ray bursts have led in the past few years to rapid progress in our understanding of this phenomenon. Many questions, both phenomenological and fundamental, remain, however, unanswered. In this talk I will (i) briefly review the progress triggered by the observations of BeppoSAX, HETE and SWIFT, and (ii) outline the main open questions, with emphasis on puzzles raised by recent SWIFT observations.