

Supernovae: Forging Galactic Archaeology, Chemical Evolution and Cosmology (DANZ-sn2026)

A Conference in memory of John Danziger

14-18 September 2026, Hotel del Golfo (Elba, Italy)

List of Participants

Magda Arnaboldi (ESO)

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Arianna Vasini (University of Insubria, Como, Italy)



List of Abstracts:

Magda Arnaboldi

Stretched, distorted and warped: the effects of the recent major merger event onto the older stellar disc in the Giant Andromeda galaxy

The Giant Andromeda galaxy presents a kinematically hot stellar disc out to 20-30 kpc which has been globally affected by a star formation episode 2-4 Gyrs ago. Such hot stellar disc can be linked to the major (mass ratio 1:4) merger event associated with the Giant Stellar Stream (GSS), the North-East and Western shelves structures in the galaxy's inner halo (25 kpc reported by Mackey et al. (2019). These results provide strong and independent arguments in support of a relatively recent major merger in M31.

Dietrich Baade

Working with John Danziger

Fabrizio Bocchino

An optical/X-ray view of the Calvera supernova remnant

The discovery of a radio ring around the high galactic latitude Calvera pulsar has given new impulse to the study of supernova remnant off the plane. X-ray, optical and gamma-ray emission has been associated to this shell, but their interpretation is still an open issue. I will review the optical/X-ray emission of this object and present new results we obtained thanks to recent deep Ha and spectroscopic observations, which may shed light on the nature of the multi-wavelength SNR emission.

Giuseppe Bono

Radial metallicity gradients



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We plan to discuss the role that iron metallicity gradients play to investigate the early formation and evolution of the main Galactic components together with the identification and characterization of previous merging events. In particular, we focus our attention on the kinematic criteria currently adopted for tracing back in space and in time different stellar tracers and on the use of different chemical planes for removing the kinematic degeneracy. We also plan to discuss similarities and differences of the "odd couple" Milky Way/Andromeda-- and the comparison with external galaxies.

Maria Teresa Botticella

The transient Universe in the multimessenger era

The coming decade will see an unprecedented convergence of wide-field, high-cadence synoptic surveys across the optical and radio domains, alongside high-energy observatories and next-generation gravitational-wave and neutrino facilities. Together, these capabilities provide unparalleled opportunities to address some of the most pressing questions about the dynamic Universe and to open entirely new windows of discovery. Time-domain and multi-messenger astrophysics are therefore entering a golden age and now represent a frontier area of research. This contribution will present an overview of this landscape and highlight the scientific potential expected to unfold in the coming years.

Patrice Bouchet

Supernova SN 1987A and John Danziger

The outburst of the supernova SN 1987A occurred while John Danziger was on an observing run at ESO, La Silla. We observed it with the naked eye together. Since that time, he and I have not stopped observing this iconic object with many telescopes, from the ground and from space and in all wavelength ranges, mainly in the infrared, near and medium. I will summarize the most important results obtained during this quest: from the discovery of dust condensation in the ejecta to its study at various epochs, to the abundances calculations at early and late time, through the determination of the most complete bolometric curve ever obtained for a supernova, and the first ever images of a supernova and its close environment in the thermal infrared. Finally, I will mention the plans we had together to continue this



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study, and I will stress the fundamental role played by John Danziger in the observations of SN 1987A and their subsequent analyses for nearly 40 years.

Francesco Calura

Interstellar Dust Production and the Role of Supernovae: From Local Remnants to the Early Universe

Interstellar dust is a fundamental component of galaxies, shaping their spectral properties and regulating the chemical evolution of the interstellar medium (ISM). This presentation reviews the physical processes governing the galactic dust budget, with a particular focus on the role of core-collapse supernovae (SNe). While SNe are traditionally considered rapid and efficient dust producers, their net contribution remains highly uncertain due to the destructive effects of reverse shocks and the competition with other processes. I examine observational constraints from nearby supernova remnants, such as SN 1987A and Cas A, and compare them with studies of the dust mass budget and interstellar depletion pattern in high-redshift galaxies. I discuss how stellar dust production, supernova-driven destruction, and interstellar grain growth in cold molecular clouds jointly shape the chemical abundances in the ISM. I conclude by highlighting the need for next-generation, high-sensitivity far-infrared missions to reconcile theoretical models with the observed cosmic evolution of the dust mass density.

Enrico Cappellaro

50 years of transient search: from Asiago Schmidt telescopes to Euclid

Starting from the heritage of the Asiago Supernova Search I have been fortunate enough to experience nearly the entire half-century explosion of transient research. I will be retracing the crucial breakthroughs I witnessed—from unexpected cosmic surprises to the complex puzzle of multi-messenger sources. We'll then look toward the horizon: the new frontier of discovery being opened by Euclid's transient search.

Gabriele Cescutti

On the importance of faint Supernovae in the Early Galaxy



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The chemical abundance patterns of extremely and ultra metal-poor stars provide valuable clues on the nature of the first supernovae and the early chemical enrichment of the Milky Way. Using a stochastic chemical evolution model, we investigate the role of faint supernovae in shaping these signatures, focusing on carbon, nitrogen, oxygen, and neutron-capture elements. We find that including faint supernovae significantly improves the agreement between model predictions and the observed abundances of the most metal-poor stars. In combination with the contribution of rotating massive stars, faint supernovae appear to be a key ingredient in reproducing the chemical fingerprints of the earliest stages of Galactic evolution.

Luca Ciotti

Metallicity gradients and internal dynamics of ETGs

Back in the '90s, John Danziger authored significant observational papers on the dynamics, stellar populations, and metallicity gradients in early-type galaxies. These papers prompted me to study the problem from the point of view of phase space. In fact, metallicity gradients in stellar systems supported by velocity dispersion have a dynamical interpretation quite less trivial than metallicity gradients in disk galaxies, where orbits are almost circular. In this talk I will discuss, starting from John's papers, how metallicity gradients in early-type galaxies are related to their internal dynamics and how the obtained information sheds light on the processes involved in the formation of these systems.

Massimo Della Valle

Capturing the Birth of Supernovae in Real Time

Transient astrophysics will remain a major frontier of discovery in the multi-messenger era. Supernovae, Kilonovae, Gamma-ray Bursts, and compact-object formation connect electromagnetic emission with gravitational waves and neutrinos. Most of the key physics occurs during the first seconds/minutes to hours after the onset of the event, while current surveys usually revisit the same region of the sky only after days. As a result, we normally observe the aftermath, but rarely the birth of these phenomena. *Mezzocielo* telescope addresses this problem through continuous high-cadence monitoring of large areas of the sky, allowing us to detect



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transient events in real time and directly connect their earliest optical emission with GW and neutrino signals.

Ortwin Gerhard

Galactic bulge chemodynamics

Emanuele Greco

The 40-Year Hunt for the Elusive Compact Object in SN 1987A

In February 2027, SN 1987A—the most famous and only naked-eye supernova to explode since the invention of the telescope—will turn 40 years old. While the detection of neutrinos from the explosion clearly pointed to the formation of a neutron star at its core, for several decades there was no direct evidence of its existence. The most likely explanation for this prolonged non-detection is absorption by the thick, opaque layer of unshocked ejecta in which the compact object is embedded. In this talk, I will review the history of this ongoing search, detailing recent evidence across the electromagnetic spectrum that strongly suggests emission from this elusive compact object. Finally, I will outline the current state of research and present ongoing projects aimed not only at better predicting the evolution of the SN 1987A system, but also at constraining the true nature of this long-sought compact object.

Laura Greggio (delivered by Francesca Matteucci)

The Distribution of the Delay Times of Type Ia Supernovae

Type Ia Supernovae provide a large fraction of the Iron yield to the interstellar medium, and they do so on a long timescale compared to that of Type II Supernovae, which provide the alpha elements. Because of this, stellar populations characterized by a high alpha-to-Iron abundance ratio are thought to be formed over a short timescale. How short this timescale is depends on the delay times of SNIa progenitors, which span a wide range, from tens of million years up to the Hubble time. The shape of the distribution of the delay times of SNIa's controls the



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timescale for the Iron enrichment of the interstellar medium. In this talk I will illustrate how fundamentals of stellar evolution constrain this distribution for various options of SNIa progenitors, and which are the most important parameters which play a role.

Valeria Grisoni

Co-evolution of the Milky Way thick and thin discs with the revised parallel model

Observational data have revealed a clear dichotomy in the $[\alpha/\text{Fe}]$ versus $[\text{Fe}/\text{H}]$ diagram of the Milky Way thick and thin disc stars, whose origin is still a matter of debate in Galactic archaeology. Many recent observational studies have shown evidence of a co-evolution phase between the high- and low- α disc sequences, as well as the presence of very old low- α stars. We aim to revise the parallel chemical evolution model that assumes two parallel histories of star formation for the two discs in order to explain such a co-evolution phase. Our revised parallel model with a pre-enriched and delayed (roughly 1 Gyr) second infall episode explains not only the abundance patterns of high- and low- α stars but also stellar age distributions for the selected observational sample. With our chemical evolution model, we predict a short co-evolution period in between the two phases and we can explain the presence of old low- α stars, as recently observed.

Artur Hakobyan

Constraining type Ia supernova progenitors within host galaxy discs

Over the past decade, compelling evidence has emerged that supports the existence of multiple progenitor channels leading to Type Ia supernovae (SNe Ia). Among the different channels, SNe Ia originating from sub-Chandrasekhar mass carbon-oxygen white dwarfs (WDs) have garnered significant attention. In these systems, an initial helium shell detonation - fed by material accreted from a binary companion - triggers a secondary detonation in the core of the primary WD. This double-detonation scenario predicts a critical relationship between the progenitor system's age and the peak luminosity of SN: younger progenitors result in brighter SNe. I will present our latest findings that validate the predicted correlation. Our analysis focuses on the spatial distribution of nearby SNe Ia within their host galaxy discs, employing diverse methods to estimate progenitor (dynamical) ages. These methods



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include analysing the relationship between SNe photometric properties, such as light curve decline rates, and their vertical distributions in discs, as well as their distances from host spiral arms. Additionally, I will present our results on the characteristics of SNe Ia host populations in the context of the "star formation desert" phenomenon and beyond. Finally, I will detail the questions still open and provide some perspectives on future research.

Luca Izzo

Novae as Galactic lithium factories: further confirmations from multi-wavelength surveys

Classical Novae have been proposed as one of the main factories of lithium in our Galaxy. In this talk, I will present further evidences for the presence of lithium in the ejecta of classical novae from a multi-wavelength analysis of bright events. While the lithium yield derived from these observations are about one order of magnitude greater than theoretical predictions, they solidify novae as main Lithium producers in the Milky Way, and likely in the Universe.

Rolf Kudritzki

Extragalactic Stellar Spectroscopy

The determination of chemical composition and distance is crucial for investigating the formation and evolution of star forming galaxies. Stellar absorption line studies based on quantitative spectroscopy provide an attractive alternative to the standard techniques using the emission lines of HII regions for chemical composition or stellar photometric methods for distances. I will introduce a number of newly developed methods

- multi-object spectroscopy of individual blue and red supergiant stars, the brightest stars in the universe at visual and NIR wavelengths,
- NIR spectroscopy of super star clusters,
- spatially resolved optical spectroscopy of the integrated light of stellar populations in the disks of star forming galaxies,
- the stellar flux-weighted gravity luminosity relationship for distance determinations and a new determination of the Hubble constant



and present results accumulated over recent years. I will then discuss the scientific perspectives and potential of these methods for the use of future Extremely Large Telescopes and the new telescopes in space.

Xiaowei Liu

Exploring the local dynamic universe with Mephisto

In the talk, I will present the Mephisto telescope, some results of simultaneous multi-band observations of SNe and GRBs, as well as a pilot survey of SNe in the Coma Cluster.

Francesca Matteucci

The roles of supernovae in the chemical evolution of the Galactic bulge

Old and new models for the evolution of the Galactic bulge will be reviewed. Starting from the metallicity distribution function of the bulge, we can predict the $[X/Fe]$ vs. $[Fe/H]$ relations. Matteucci & Brocato in 1990 predicted that the $[\alpha/Fe]$ vs. $[Fe/H]$ relation in the bulge should have a longer plateau than the relation in the solar vicinity. This can be interpreted by means of the time-delay model where the different roles of supernovae of different type (core-collapse and Type Ia) in the chemical enrichment can explain the behaviour of the $[\alpha/Fe]$ ratios. The conclusions of the old models were that the bulge should have formed very quickly by means of a strong burst of star formation. More recently, it has been evident that the bulge hosts two main stellar populations, one more metal poor (the classical bulge) that must have formed very fast and another more metal rich that has likely been accreted from the inner disk regions. The most recent bulge models and their results will be discussed. Finally, I will briefly show the only paper I co-authored with my husband John Danziger about elliptical galaxies.

Ivan Minchev

Reconstructing the Spatially Resolved Star Formation History of the Milky Way Disk

Reconstructing the spatially resolved star formation history (SFH) of the Milky Way disk is essential for understanding how the Galaxy assembled and grew. However,



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most such reconstructions implicitly assume that stars formed near their present-day radii, even though stellar radial migration redistributes populations across the disk over cosmic time. Recent work with cosmological simulations has shown that this effect can strongly and systematically bias inferred SFHs, suppressing true peaks, broadening star formation episodes, and distorting signatures of inside-out growth. In this talk, I will show how the spatially resolved SFH of the Milky Way disk can be reconstructed by formation site, using stellar birth-radius estimates rather than present-day stellar positions. Combining this approach with Gaia-era chemodynamical constraints and large spectroscopic surveys makes it possible to recover a more physical picture of when and where stars formed in the Galactic disk. Recent results indicate that the Milky Way is consistent with inside-out disk growth, with substantial radial redistribution of stellar populations over time and important consequences for the interpretation of local age and abundance distributions. These results highlight that accounting for radial migration is essential for interpreting the Milky Way's formation history, and will become increasingly important for fully exploiting the scientific potential of Gaia DR4 and DR5.

Paolo Molaro

An Hypernova in Thamnos-2?

Thamnos is an accreted Galactic substructure, possibly associated with the Sequoia merger event, in which the Be-rich star BPM3066 was first identified by Monaco et al. (2025). In a new survey, we identify four additional members of Thamnos-2 exhibiting significant beryllium overabundances. Moreover, the two previously known Be-rich stars, HD 106038 and HD 132475, whose origin has remained unexplained, are also found to have kinematics consistent with membership in Thamnos-2. Thus, all currently known stars with anomalous beryllium abundances appear to be associated with this accreted structure. No comparable population of Be-rich stars is known elsewhere in the Galaxy, pointing to a rare and localized enrichment event. The observed excess $A(\text{Be})/A(\text{Li})$ ratio bears the signature of spallation reactions, indicating a highly energetic event in which fast CNO nuclei fragmented through collisions with the surrounding medium. The beryllium enhancement is accompanied by elevated silicon abundances and relatively low oxygen. The silicon enhancement is likewise consistent with enrichment by a hypernova. However, no other expected signatures are present and a correlation between beryllium and neutron-capture elements is also detected. Such an event could have rapidly enriched the surrounding gas to $[\text{Fe}/\text{H}] \approx -1.5$, naturally



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explaining the relatively high metallicities of stars that formed from this material despite their old ages (≈ 13 Gyr). We discuss this scenario in the context of recent models of hypernova-driven nucleosynthesis (more in Molaro Bonifacio Caffau Monaco Cescutti 2026 A&A in press, arXiv:2607.08179).

Marta Molero

Constraining r-process nucleosynthesis with multi-objective Galactic chemical evolution models

The astrophysical site(s) of the rapid neutron-capture process (r-process) remain uncertain, with competing scenarios such as neutron star mergers and magneto-rotational supernovae offering different predictions for the timing, frequency, and yield of heavy-element pollution. In this talk, I will present a systematic, data-driven exploration of the range of astrophysical conditions under which r-process enrichment can reproduce the observed trends of multiple neutron-capture elements in the Milky Way, focusing in particular on whether a common set of r-process parameters can simultaneously explain the chemical evolution of several heavy elements of interest. A large grid of one-infall, homogeneous Galactic chemical evolution models is constructed by varying key parameters of r-process nucleosynthesis, and their capability of reproducing the observed abundance trends across multiple neutron-capture elements simultaneously is evaluated by means of a multi-objective optimization approach based on Pareto front analysis. I will discuss in particular why heavy neutron-capture elements can be reproduced simultaneously with Eu, while the lighter ones present stronger conflicts, and comment on the consequences this has for r-process universality. If no single class of r-process events can simultaneously account for the chemical evolution of both light and heavy neutron-capture elements, more than two astrophysical sources might be necessary. I will discuss their characterization as well as the implications this has for both the light and the very heavy ends of the r-process abundance pattern.

Chi Thanh Nguyen

A galactic chemical evolution for Li

The evolution of Galactic Li abundances typically indicates two main aspects: a plateau at low-metallicity ($[\text{Fe}/\text{H}] < -1$) and an enrichment evolution at higher



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metallicities. While the plateau is commonly related to the long-standing ‘cosmological Li problem’, the enrichment evolution currently favours contribution from nova explosions. In this talk, I will present a chemical evolution model, which takes into account corrections from stellar evolution and nova Li production, to trace the evolution of Li in the Galactic thin disc.

Salvatore Orlando

Cassiopeia A as a Laboratory for Core-Collapse Supernova Physics

Core-collapse supernova remnants (SNRs) provide a direct window into the physics of stellar explosions and the final stages of massive-star evolution. Cassiopeia A, in particular, stands as a cornerstone object: its complex morphology and chemical structure preserve a detailed record of explosion asymmetries, nucleosynthesis, and compact-object formation. Recent observations, including transformative results from JWST, have revealed unprecedented structure in its ejecta, placing stringent constraints on explosion models as well as on the final evolutionary stages of the progenitor star. In this talk, I will present state-of-the-art simulations of neutrino-driven explosions that follow the evolution from core collapse to the remnant phase, with a focus on reproducing the observed properties of Cassiopeia A. These models establish a direct connection between the explosion mechanism and the remnant’s morphology and chemical distribution, while highlighting the crucial role of the circumstellar medium (CSM) in shaping the remnant through its interaction with the expanding ejecta. By combining simulations and observations, Cassiopeia A emerges as a powerful probe of both the supernova engine and the progenitor system, enabling us to reconstruct the final phases of its evolution and mass-loss history.

Marco Palla

Local Group Galaxies as Probes of Elemental Nucleosynthesis

The understanding of elemental nucleosynthesis and the astrophysical origin of chemical elements has been object of intense study in the last decades. A great number of works have tackled this matter by investigating the abundance patterns of the Milky Way, with their interpretation used as probes of the nucleosynthetic sources and processes acting in shaping cosmic abundances. Despite this, our view remains only partial, as it is strongly biased towards a system with a well-defined formation history and a limited range of variations in its different stellar



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components. In this context, dwarf satellites galaxies of the Local Group offer a complementary perspective. Indeed, these systems—ranging from the massive Magellanic Clouds to small Dwarf Spheroidal and Ultra-Faint Dwarf systems—exhibit diverse evolutionary features that provide unique opportunities to break persistent degeneracies regarding the origin of several element classes. In this talk, I will demonstrate the power of this approach by comparing outputs from detailed chemical evolution models, tailored to the unique star-formation histories of diverse dwarf galaxies, with recent stellar abundance measurements within the Local Group. I will focus specifically on the evolution of neutron-capture elements, including species tracing both the rapid (r-process, e.g., Eu) and slow (s-process, e.g., Zr, Ba, La) channels. Our results show that the abundances in dwarfs reveal significant inconsistencies in production scenarios that otherwise appear robust in describing the Milky Way, particularly concerning r-process enrichment. Furthermore, these abundance patterns provide critical insights into the physical characteristics of the stellar populations, such as potential variations in the stellar Initial Mass Function relative to the Galaxy. Ultimately, this modelling provides a crucial test-bed for future observations of Local Group systems, in preparation for the high-precision data expected from next-generation spectroscopic surveys.

Ferdinando Patat

The Lunar Gravitational Wave Antenna

The Lunar Gravitational Wave Antenna (LGWA) is a proposed observatory on the Moon designed to detect low-frequency gravitational waves using high-precision seismology. The concept takes advantage of the Moon's uniquely quiet seismic environment, absence of an atmosphere, and stable thermal conditions to measure minute deformations in the lunar crust induced by passing gravitational waves.

LGWA aims to explore the intermediate frequency band that lies between the sensitivity ranges of ground-based interferometers such as LIGO, Virgo, and KAGRA, and future space-based detectors like LISA. In this talk, I will introduce the project and highlight its key scientific objectives.

I will begin by sharing a few personal memories of John, who was my PhD supervisor at ESO in 1994–95.

Pedro Alonso Palicio



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The Delay-Time Distribution in analytic solutions of Chemical Evolution Models and its constraints from cosmic observations of Type Ia Supernova Rates.

Stellar chemistry provides important information about how the composition of the interstellar medium evolves with time, and chemical evolution models constitute a key tool for its interpretation. However, historically, their analytic treatment of iron enrichment has been restricted to oversimplified cases due to the longer timescales on which Type Ia SNe operate. In this talk, I will introduce the analytic solution presented in Palicio et al. (2023b), which extends the Instantaneous Recycling Approximation through the DTD formalism to account for the contribution from Type Ia supernovae. Using this analytic solution, we explore how different DTDs affect the evolution of $[\text{Si}/\text{Fe}]$ and $[\text{O}/\text{Fe}]$ as a function of $[\text{Fe}/\text{H}]$ in the Milky Way, adopting both one- and two-infall models for the solar neighbourhood. Additionally, we illustrate how cosmic observations of Type Ia SN rates constrain the DTD, favouring the single-degenerate channel and requiring at least 34% of Type Ia SNe to arise from it, while a mixed single- and double-degenerate progenitor scenario cannot be ruled out (Palicio et al. 2024).

Silvia Pellegrini

Supernovae and the hot interstellar medium of early-type galaxies

Early-type galaxies harbor large amounts of hot gas that is heated by energy injected by Type Ia supernovae (SNIa's). Thanks to their random explosions, SNIa's deposit energy within the galaxies in a distributed way, acting differently from the active galactic nucleus that tends to inject energy in a more localized way (e.g., channelled into jets or winds). Under certain conditions, SNIa's can even sweep gas out of the galaxies. While accounting for a number of observed X-ray properties of early-type galaxies, these conclusions on the other hand imply a puzzle. In fact, SNIa's also provide metals that should enhance significantly the ISM abundance. Instead, abundance measurements are lower than expectations, pointing to the need for a revision of standard assumptions. The presentation will consider these aspects, also aided by results from high resolution hydrodynamical simulations that follow the circulation of energy, baryons and metals inside and outside galaxies.

Emanuele Pepe

Yields from massive binaries and galactic chemical evolution



Massive stars in interacting binaries experience mass transfer, altering their evolution and potentially their nucleosynthetic yields. Despite the key role of massive stars in the chemical enrichment of galaxies, the impact of binary-stripped stars on the chemical evolution of the Milky Way remains poorly explored. We investigate this effect using recent metallicity-dependent yield calculations for massive binary-stripped stars within a detailed Galactic chemical evolution model that follows the evolution of 22 chemical species. We compare predictions obtained with standard nucleosynthetic prescriptions and with the new stellar yields of Farmer et al. (2023) for both single and binary massive stars. We find that including metallicity-dependent binary yields produces only minor differences in solar abundances and in the $[X/Fe]$ – $[Fe/H]$ relations, confirming previous studies. The adoption of Farmer et al. single star yields allows us to reproduce both the solar potassium abundance and the observed $[K/Fe]$ trend without ad hoc modifications to nucleosynthesis prescriptions. The same yields also improve the agreement with observations for Mg and Ca. These results indicate that metallicity-dependent binary yields have a limited impact on Galactic chemical evolution, while updated single massive-star yields can significantly improve the modelling of specific elements.

Nikos Prantzos

On the evolution of lithium in the Milky Way

Alvio Renzini

Failed Supernovae May Help Making Globular Clusters and Compact Galaxies in the Early Universe

Observations of the precursors of core-collapse supernovae have so far failed to detect precursors more massive than $\sim 20 M_{\odot}$, supporting the notion that stars more massive than this limit may directly sink into black holes without releasing much kinetic and radiative energy. If this is the case, supernova feedback would be delayed by ~ 10 Myr past an episode of star formation. The implications of this assumptions for the formation of globular clusters and other compact objects will be explored, especially concerning the early Universe as revealed by JWST.

Michael Rich



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The chemical evolution and star formation history of the bulge and Terzan 5

The remarkable massive cluster Terzan 5 exhibits a trend in $[\alpha/\text{Fe}]$ vs $[\text{Fe}/\text{H}]$ similar to that exhibited by the Galactic bulge and has a metal rich population resembling that of the Galactic Center Nuclear Star Cluster. This system had been known to exhibit 2 bursts of star formation at 12 and 5 Gyr. Recent HST/JWST observations find two additional main sequence turnoff populations at roughly 2 Gyr, making the system unlikely to have formed from the merger of clusters. This suggests that Terzan 5 commenced with a high initial mass as high as $10^{10} M_{\odot}$, perhaps including dark matter. Clusters similar to Terzan 5 and Liller 1, another unusual system, may have helped to build the bulge and possibly form the NSC. I will examine clues to the enrichment history in the bulge field, NSC, and Terzan 5 with the aim of illuminating the role of bulge fossil fragments like Terzan 5 had in their formation.

Federico Rizzuti

3D simulations of massive stars as supernova progenitors

The evolution of massive stars is characterized by complex multi-dimensional processes, such as convection and magnetic fields, which play a crucial role in their late stages shaping the final pre-supernova structure and the conditions for the collapse. However, 1D stellar evolution models describe these phenomena through parametrized prescriptions, which limit their predictive power. On the other hand, multidimensional hydrodynamic simulations are able to reproduce these physical processes over short timescales but in high detail. In this talk, I will present results from 3D simulations of massive stars during their advanced burning phases, produced including a nuclear network to fuel convection and self-sustained magnetic fields. I will discuss how these simulations allow to study the interplay between nuclear burning, turbulent mixing, and magnetic fields in the final stages before collapse, providing insights for refining the 1D stellar models and improving their application in supernova explosion models.

Nils Ryde



Chemical Abundances and Chemical evolution of the Stellar Populations in the Galactic Center

The Galactic Centre contains several stellar populations that record how the innermost Milky Way formed and evolved. While photometric star-formation histories, metallicity distributions, and kinematics have already revealed important structure in the nuclear stellar disc (NSD) and nuclear star cluster (NSC), detailed chemical abundances add a complementary view by tracing the origin of the gas and the relative importance of different enrichment channels. I will present recent high-resolution near-infrared abundance work on M giants in the inner bulge, the NSD, and the NSC. We have now measured detailed abundances for nearly two dozen elements in these heavily dust-obscured regions. The results show that the dominant old metal-rich populations in the NSD and NSC are, in most elements, similar to the inner bulge, suggesting a close connection to the early inner Milky Way. At the same time, some features, in particular enhanced Na, point to additional chemical processing in the Galactic Centre environment. Although the present samples are still small, they show that detailed abundance studies of the Galactic Centre are now possible and provide a new way to connect stellar populations, gas flows, and chemical evolution in the central Galaxy.

Mathias Schultheis

Diffuse interstellar bands

Diffuse interstellar bands (DIBs) are interstellar absorption features originating from the interstellar medium, quasi-consensually attributed to large organic molecules. DIBs exist in the optical and in the infrared. Most of the DIBs show a tight relation with interstellar reddening, and can therefore be used as an excellent tracer of the ISM. Beside the equivalent width of the DIBs, radial velocities profiles can be derived and be used to study e.g the Galactic rotation curve of the carrier. I will present the capacity of the Gaia-Radial Velocity Spectrometer (RVS) in Gaia DR3 to reveal the spatial distribution of the unknown molecular species responsible for the most prominent DIB at 862 nm in the RVS passband exploring the Galactic interstellar medium within a few kiloparsecs from the Sun. Nearly 500.000 DIB measurements have been obtained in a homogeneous way covering the entire sky, making it the largest sample of DIB measurements so far. I compare spatial distributions of the DIB carrier with interstellar reddening and find evidence that DIB carriers are present in a local bubble around the Sun which contains nearly no dust. I will present how



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machine learning techniques can improve significantly the detection of these weak bands and give some outlook for the next Gaia data release DR4.

Lapo Sgatti

The MINCE project: A detailed analysis of 37 metal-poor and subsolar metallicity stars

One of the key ways to study the formation and evolution of the Milky Way is through the chemical abundance trends of its stellar populations. In particular, heavy elements ($Z > 30$) produced through neutron-capture nucleosynthesis are powerful tracers of Galactic history, since their production sites — such as neutron star mergers, core-collapse supernovae, and AGB stars — operate on different timescales and leave distinct chemical signatures. The Measuring at Intermediate metallicity Neutron-Capture Elements (MINCE) project aims to build a homogeneous catalogue of about 1000 high-quality stellar spectra to investigate the origin of these elements and reconstruct the chemical enrichment history of our Galaxy. In this talk, I will present the fourth MINCE sample, consisting of 37 stars observed with the Telescopio Nazionale Galileo (TNG) and the Nordic Optical Telescope (NOT). I will guide you through the main steps of the analysis, from target selection to atmospheric parameter determination to kinematic classification of stars into Galactic substructures and the derivation of chemical abundances for up to 26 species. The main results will then be discussed in the context of Galactic Chemical Evolution (GCE) models. In addition, I will provide an update on the current status of the project, including ongoing developments, available online resources, and forthcoming publications.

Mattia Sormani

The impact of stellar feedback in driving inflows in the Galactic centre

We perform hydrodynamical simulations of the gas flow in the central region of the Milky Way to study the effects of supernova and stellar feedback in driving a radial inflow from the Central Molecular Zone (CMZ, $R \sim 200$ pc) to the Circumnuclear Disk (CND, $R \sim 5$ pc). The simulations include a realistic Milky Way barred gravitational potential, a cooling function coupled to a non-equilibrium chemical network, gas self-gravity, star formation, supernova feedback, and radiation feedback from



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massive stars computed via on-the-fly radiative transfer. We find that: 1) Stellar feedback drives radial inflow from the CMZ to the CND through two distinct mechanisms. First, feedback-driven turbulence redistributes the angular momentum of gas clouds and produces a smooth transport of mass inward, similar to a Shakura-Sunyaev viscous accretion disc. Second, episodic inflow events occur that can increase the inflow rate by several orders of magnitude for short periods of time. 2) The time-averaged inflow rate decreases monotonically with Galactocentric radius. 3) The details of stellar feedback significantly affect the episodic inflow, but have little impact on the smooth inflow. In particular, simulations that include radiation feedback show a substantially larger number of episodic events than those with only supernova feedback.

Emanuele Spitoni

Chemical evolution models of the Nuclear Stellar Disc

The nuclear stellar disc (NSD) of the Milky Way is a dense, rotating stellar system extending over the central ~ 200 pc, thought to be primarily fuelled by bar-driven gas inflows from the inner Galactic disc. As part of the LEGARE project, we investigate whether this formation scenario can reproduce the observed chemical properties of the NSD. We use a state-of-the-art chemical-evolution model coupled with a Bayesian framework based on Markov Chain Monte Carlo techniques to reproduce the observed metallicity-distribution functions and $[\alpha/\text{Fe}]$ – $[\text{Fe}/\text{H}]$ trends. We find that gas flowing from the inner disc alone cannot reproduce the low-metallicity tail of the observed distribution, as the inner disc was already close to solar metallicity when the Galactic bar formed. Additional metal-poor inflows are therefore required to reproduce the observations, unless the low-metallicity tail is attributed to contamination by bulge stars. In the dilution scenario, the best-fitting model involves inflowing gas with a metallicity about five times lower than that of the inner disc and successfully reproduces both the observed abundance trends and the recent estimates of the NSD star formation history. Our results suggest that, alongside bar-driven inflows from the inner disc, lower-metallicity gas may have contributed significantly to the formation of the Milky Way's nuclear stellar disc.

Arianna Vasini



3D Mapping of the Central Molecular Zone: constraining cloud distances with proper motions and stellar extinctions

The Galactic Center is the region with the highest gas density in the whole Milky Way. This gas accumulates in clouds which constitute the Central Molecular Zone (CMZ). How these clouds are distributed in the CMZ is still an open question. Even though we can see their position on the skyplane we are not able to measure their distance from the Sun and we have to rely on indirect methods, which are affected by large uncertainties. I will present a new method to derive a 3D map of the CMZ which adopts the observed proper motions of the Nuclear Stellar Disc (NSD) stars and their extinction. I will show promising results obtained with mock data, in preparation to the application of the method to real NSD stars and gas distribution.

