UNIVERSITÀ DEGLI STUDI DI ENNA "KORE"

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Roberta Spartà

The Big Three Reactions for Nuclear Astrophysics: the forthcoming workshop in Strasbourg

WP8 – NA3 Astronuclear library

chetec-infra.eu

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chetec-infra.eu

Task 8.1 Complementarities and Comparisons Towards Standards: The Big Three for Evolved Stars
(PI A. Tumino / UKE, participants: INFN, UMIL, CNRS, HZDR, GUF, UHULL):

This task will network the European research program around the 12C(α,γ), 12C+12C and 22Ne(α,n) fusion reactions. The 'Big Three' reactions, yet to be fully assessed, play a key role in advanced stellar evolution phases and nucleosynthesis of massive stars.
We will establish a framework for cooperation and joint activity between experimentalists to tackle the study of the same reaction with different and complementary techniques.
…
A comparison of the various approaches will allow to discuss the reliability of the new data and to propose methods for future experimental investigations. This activity can be framed as the nucleus of a larger intercomparison effort and as ***a recipe of best practices.***
…

2 workshops

1st workshop

Topical meeting of IReNA - FA1 and ChETEC-INFRA
Nuclear reaction measurements in **Underground Laboratories**

April 5-8, 2022 - Rome Global Gateway, Rome, IT

Welcome

The Focus Area 1 (FA1) of the International Research Network for Nuclear Astrophysics (IReNA) is concerned with the determination of nuclear reaction rates of critical astrophysical importance in the laboratory using a broad range of experimental approaches, including heavy ion storage rings, deep underground laboratories, intense photon beams, neutron beams, and recoil separators at stable and rare isotope accelerator facilities.

Within FA1 topical meetings will be organized. The first edition is organized jointly between IReNA and the European network activity ChETEC-INFRA. It will take place April 5-8, 2022 at the Rome Global Gateway of the University of Notre Dame located in the center of Rome, IT.

The intention of this topical workshop is to collect information, discover possible synergies and synchronize future activities at different underground laboratories in Europe and the United States. The format of the workshop allows for few overview presentations on key topics in the morning sessions and intensive discussions during afternoon breakout sessions. The goal of the workshop is a road-map for the next 1-2 decades outlining the experimental program in the underground laboratories.

Very successful meeting covering the topics around Big3

Talks + intensive discussion

About 70 participants, 20% online

From Helium Burning Discussion [Focus on $^{12}C(\alpha,\gamma)$]

- What uncertainty do we need for 12C(α,γ)?

15% for core & shell he-burning - as compared to existing 20% uncertainty for these temperatures (15% is the minimum needed, 10% would be “the last word")

- What measurements do we need to do?

Only E1 cross section direct measurements are consistent with each other. Everything else needs improvement.

Any direct measurement of 12C+4He (gamma or recoil or both) able to compete with the 16N data on the reduced width of the subthreshold 1-state, 16N(beta-alpha) new data - Argonne results were limited by available beam-time.

R-matrix: ERNA data & ANCs from alpha-transfer data have a dominant role in the fit.

Direct low-energy measurements are extremely important because of uncertainties in the extrapolation.

- What theory calculations are needed?

Bayesian optimization | Timeline for ab-initio is ~5-7yrs from now | Value of alpha-cluster calculations?

From Carbon Burning Discussion [Focus on $^{12}C+^{12}C$]

- Recent direct measurements are not consistent in all energy ranges, why?

Gamma angular distribution: isotropic assumption is not granted. Angular distribution effect arising from the different angular coverages in experiments.

Broadening by Doppler shift. In many of the direct measurements, the integrated yield across the target is reported which isn't the same as the cross section.

- How low in energy can go direct measurements?

STELLA and LUNA-MV should be able to go below 2 MeV, in particular for the gamma-rays experiment, at LNGS you can get more than 4 orders of magnitude less environmental background.

- THM results: new experimental deuteron angular distributions. Good agreement with DWBA calculations in the experimental range.

- The hindrance is proposed as a global model. If hindrance exists in 12C+12C, it must appear in the carbon isotope system. The 12C+13C measurement rules out the hindrance prediction while confirming other models.

- For high- density environments (e.g. neutron star envelopes), how well do we understand screening effects?

From Neutron Sources Discussion [Focus on ^{13}C(α,n) and +^{22}Ne(α,n)]

^{13}C(α,n) Recent direct measurements are consistent, further, they are consistent with THM and ANC measurements.

New measurements are planned at both JUNA and LUNA MV. JUNA aims for measurements as low as 200 keV. JUNA also plans for higher precision, higher energy measurements. However, very close to a consensus rate!

^{22}Ne(α,n) still largely unknown. Several evaluations of the reaction rate exist, based on theoretical calculations. No direct measurements at the relevant energies, many spectroscopy studies of the levels involved.

A claim that needs to be debated and confirmed: the neutron strength is equal to the gamma strength.

Recent revaluation of the 22Ne(a,n) reaction rate: substantially decreased due to updated nuclear data. This results in significant changes to the nucleosynthesis in the weak branch of the s-process.

2nd workshop 29th May 2024

right after 4th ChETEC-INFRA General Assembly (27th-28th May, Strasbourg)

2nd workshop 29th May 2024

The Big-Three Reactions for Astrophysics: 12C(α,γ)16O, 12C+12C fusion, 22Ne(α,n)25Mg

29 May 2024
Europe/Rome timezone

https://agenda.infn.it/event/39760/

- Overview
- Scientific Commettee
- Scientific Programme
- Timetable
- Participant List

Contact

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Reactions involved in the helium and carbon burning, such as the 12C(α,γ) and the 12C+12C fusion, are indispensable to determine the abundances of carbon and oxygen in our universe, critical to understand the formation of life on Earth and to the life cycles of stars, including cosmologically relevant type Ia supernovae. Another key process is the 22Ne(α,n) reaction, the neutron source driving the production of heavier nuclei in the so-called weak s-process in massive stars.
The main goal of the workshop is to network the existing and forthcoming research programs around the 12C(α,γ), 12C+12C and 22Ne(α,n) fusion reactions, with a focus on the 12C(α,γ), 12C+12C reactions, the third one being the topic of the related workshop https://agenda.infn.it/event/38003/.
As main follow up, review articles on these reactions are expected to be coordinated by the participants.

Starts 29 May 2024, 09:00
Ends 29 May 2024, 17:00
Europe/Rome

Aurora Tumino
Roberta Sparta'

There are no materials yet.

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Meeting format

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In each session, an experimental studies state-of-the-art and the astrophysical impact of the reaction will be pointed out, to help the addressing of next experiments and **reaction rates will be evaluated, to be shared with the community.**

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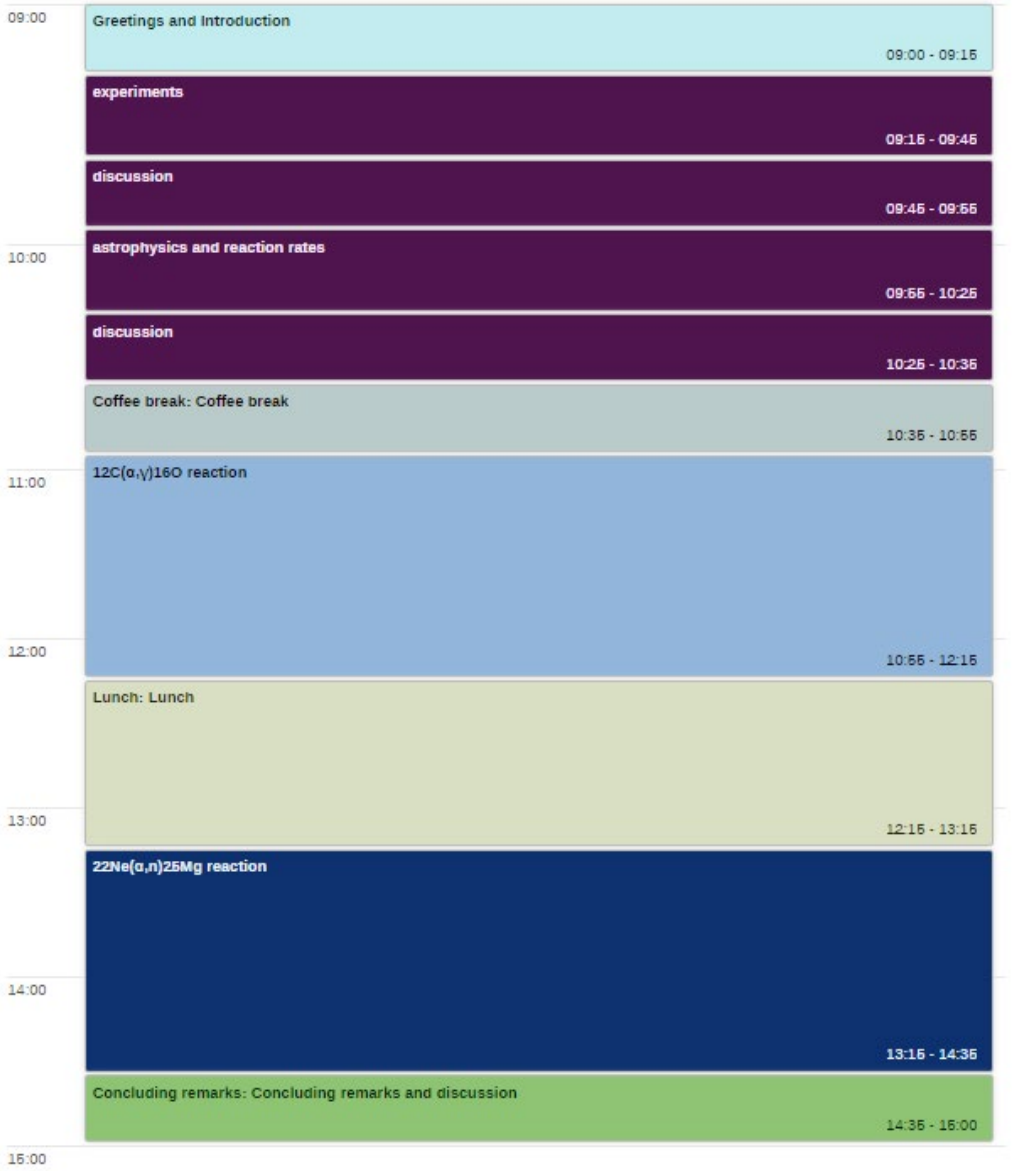

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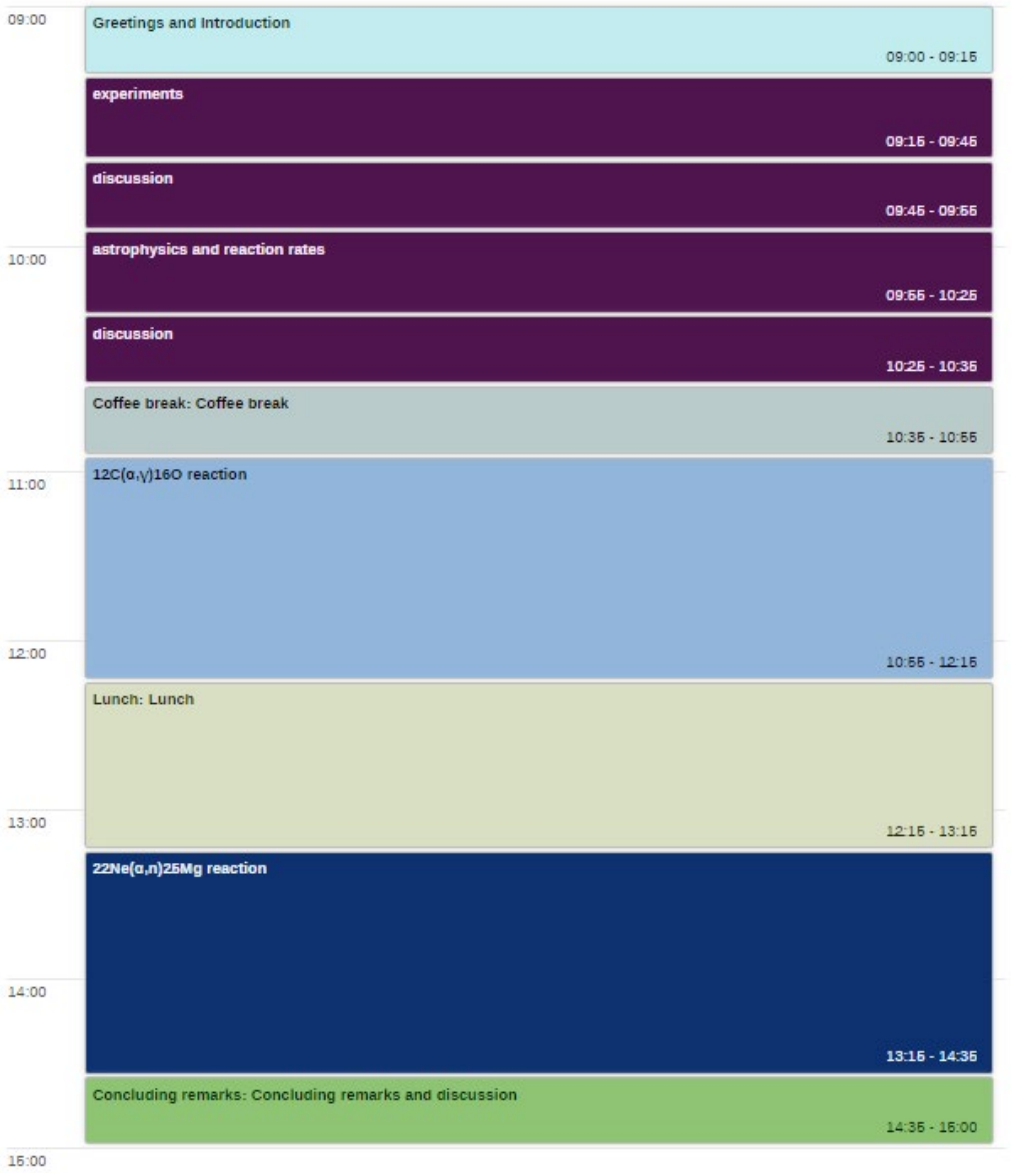

Please, register! (when available :))

https://agenda.infn.it/event/39760/

(Thanks for your attention, see you in Strasbourg)