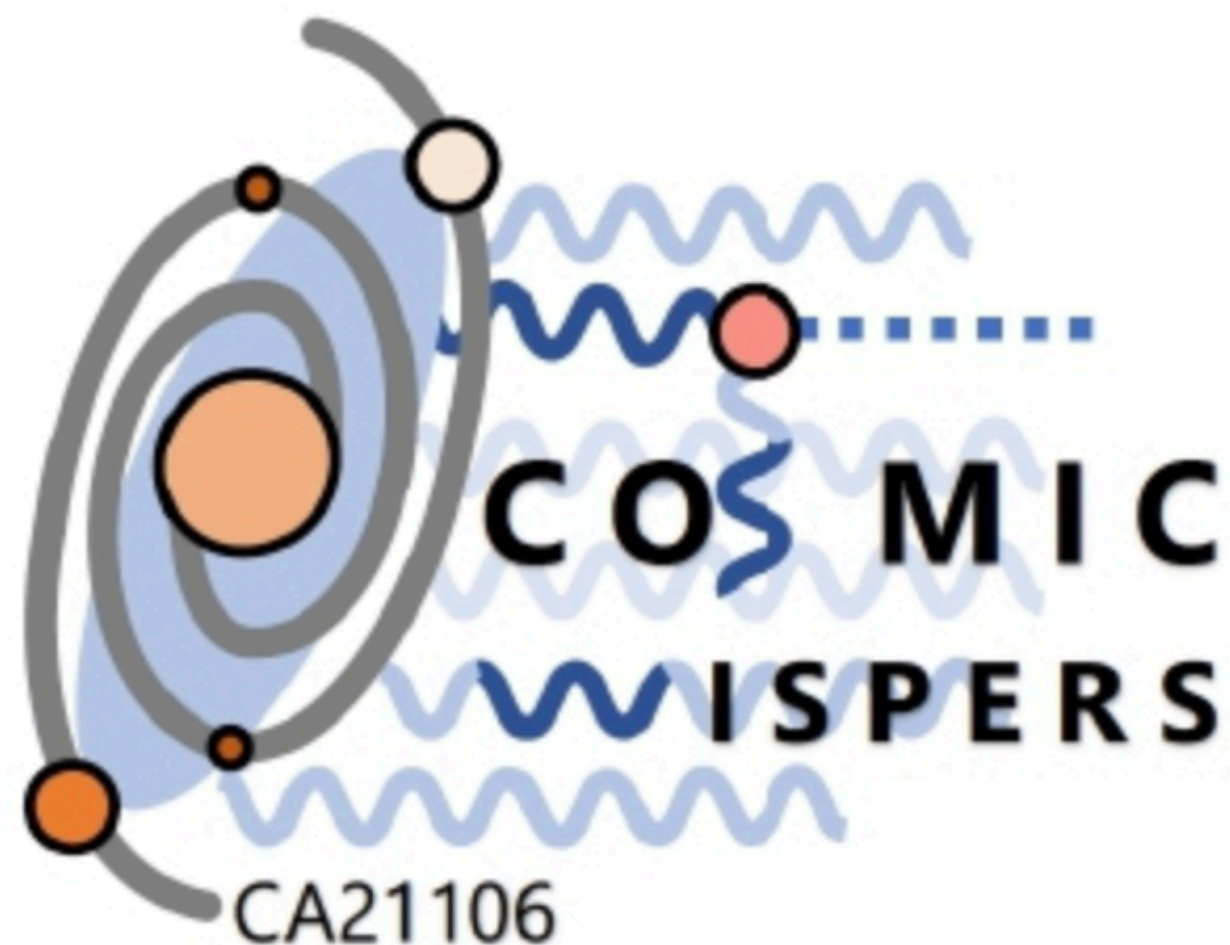


WG3: WISPs IN ASTROPHYSICS

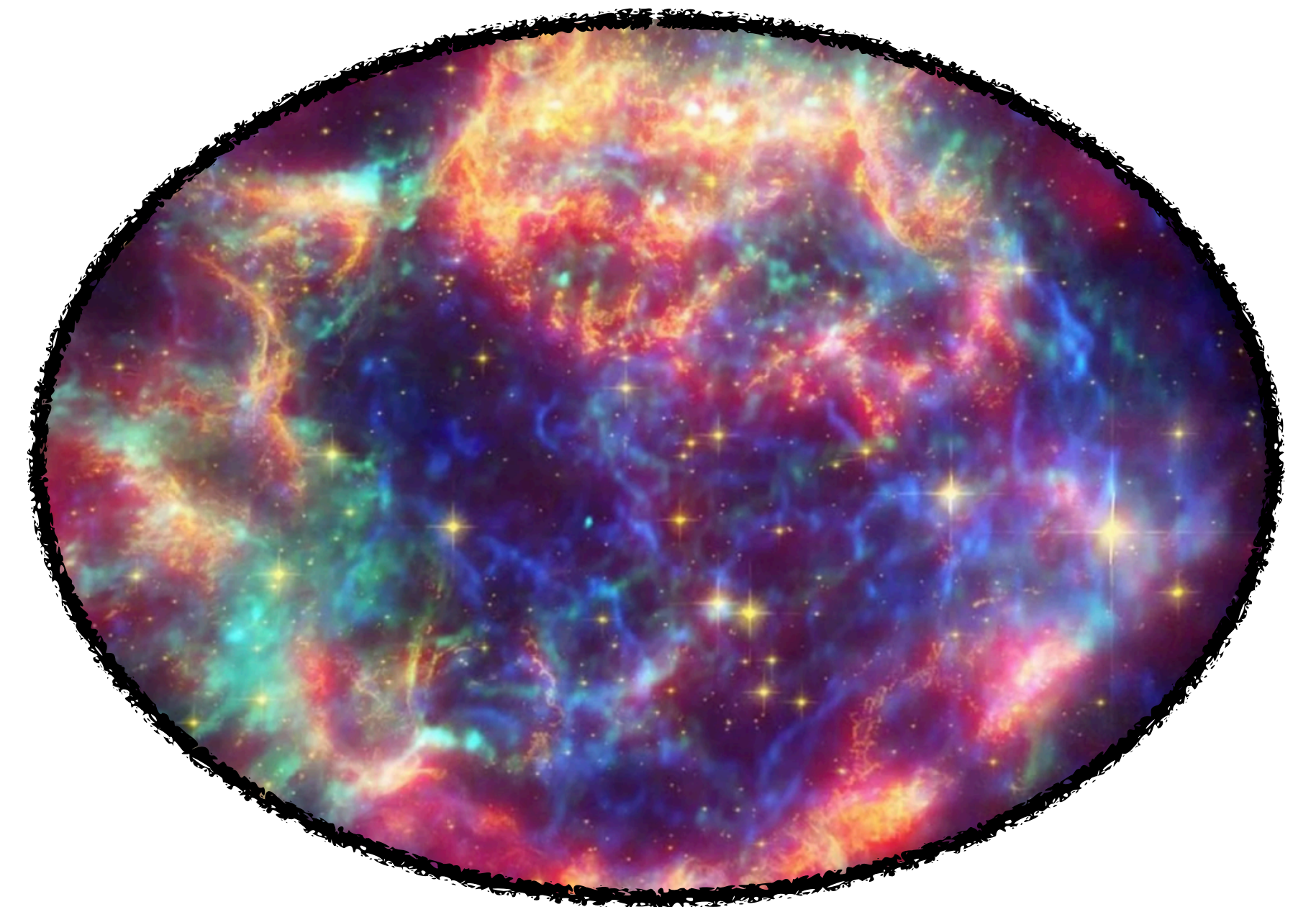
ANDREA CAPUTO
(CERN)

First Workshop COST ACTION COSMIC WISPers (CA21106)
Bari, 05-09 2023



General mission and interests of WG3

Deepen the studies of the signatures of WISPs in astroparticle physics. These include WISP oscillations into photons, WISP-induced energy loss in stellar systems and signatures from gravitational waves and from primordial black-hole superradiance



WG3 Organization and numbers

WG3 Leader: Andrea Caputo, andrea.caputo@cern.ch
WG3 Co-Leader: Oscar Straniero, oscar.straniero@inaf.it

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Name	Working Group	Country
Prof Joseph CONLON 	WG 1, WG 3	United Kingdom
Dr Marco CHIANESE 	WG 1, WG 3, WG 5	Italy
Mr Arturo DE GIORGI 	WG 1, WG 3	Spain
Dr Gaia LANFRANCHI 	WG 1, WG 2, WG 3, WG 4	Italy
Prof Alessandro MIRIZZI 	WG 2, WG 3, WG 5	Italy
Dr Andrea CAPUTO 	WG 2, WG 3	Israel
Dr Christoph WENIGER 	WG 2, WG 3	Netherlands
Mr Christopher ECKNER 	WG 2, WG 3	France
Dr Daniele MONTANINO 	WG 2, WG 3	Italy
Dr Edoardo VITAGLIANO 	WG 2, WG 3, WG 5	Israel











94! people already registered and present on the website, but we continue to get more applications!

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Large overlap with WG2, Dark Matter and Cosmology

WG2 Leader: Edoardo Vitagliano, edoardo.vitagliano@mail.huji.ac.il
WG2 Co-Leader: Javier Redondo, jredondo@unizar.es

Resume of past Activities

First, a reminder from the MoU main objective:

Primary objective: ``organize the scientific foundation for the next generation of WISPs experiments and searches, and to **promote a roadmap for the researchers**, research sponsors and the **broader scientific community**''

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- Organization of Short Term Scientific Missions (STSM);



Already few STSM missions funded!

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- Organization of Short Term Scientific Missions (STSM);
- We also organised online meetings and seminars

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Dear all,

given the (justified) excitement about the GW detection, we decided to double our events! So now next Wednesday we will start at 3pm with Prof. Alberto Sesana introducing PTA and SMBHs, and then we will pass to a series of small talks (~ 12m each) about consequences of the detection. In particular we are extremely happy to have Fabrizio Rompineve, Yann Gouttenoire, Marek Lewicki, Antonio Junior Iovino and Anish Ghoshal.

So, that's the complete plan!

Wednesday, 5th of July

- 3pm Prof. Alberto Sesana, **Nano-Hz gravitational waves: first evidence and implications**

From 4pm on the same day

- Fabrizio Rompineve (CERN), **Footprints of the QCD Crossover on Cosmological Gravitational Waves at Pulsar Timing Arrays**
- Yann Gouttenoire (Tel Aviv University), **TBC**
- Marek Lewicki (University of Warsaw), **Cosmic Superstrings Revisited in Light of NANOGrav 15-Year Data**
- Antonio Iovino (La Sapienza University of Rome), **The recent gravitational wave observation by pulsar timing arrays and primordial black holes: the importance of non-gaussianities**
- Anish Ghoshal (University of Warsaw), **Probing the Dark Matter density with gravitational waves from super-massive binary black holes**

See you all at this Zoom address on that very day! <https://cern.zoom.us/j/66024461469?pwd=QzBhemdRZVlmNitKemNLR1V3eXNsUT09>

Best,

Andrea

Organised together with WG2!

In line with the MoU objective "Coordinate and support in a synergic way WISPs searches carried on **by the different WGs**, in order to stimulate and consolidate collaborations"

200 participants! Event about the recent Nanograv GW discovery

The screenshot shows a Zoom meeting slide with the following content:

- Population parameters**
 - 1-Galaxy merger rate \longleftrightarrow MBHB merger rate affects the number of sources at each frequency $\rightarrow N_0$
 - 2-MBH mass - merging galaxy relation affects the mass of the sources $\rightarrow M_c$
- Local dynamics**
 - 1-Accretion (when? how?) affects the mass of the sources $\rightarrow M_c$
 - 2-MBHB - environment coupling (gas & stars) affects the chirping rate of the binaries $\rightarrow \gamma$ affects the eccentricity \rightarrow chirping rate $\rightarrow \gamma$ & single source detection

The slide also features a mathematical equation for the gravitational wave strain $h_c^2(f)$ and a power-law relationship $h_c(f) \propto n_0^{1/2} f^{-\gamma} M_c^{5/6}$. Hand-drawn yellow and green circles highlight specific terms in the equation and the power-law relation. Two diagrams on the right show trajectories in a 2D plane, one with a red arrow pointing towards a blue line and another with a red arrow pointing away from a blue line.

First, a reminder from the MoU main objective:

Primary objective: ``organize the scientific foundation for the next generation of WISPs experiments and searches, and to **promote a roadmap for the researchers**, research sponsors and the **broader scientific community**''

- Organization of Short Term Scientific Missions (STSM);
- We also organised online meetings and seminars
- Contribution to the COST-Action school (next week!)

Topics and Lecturers

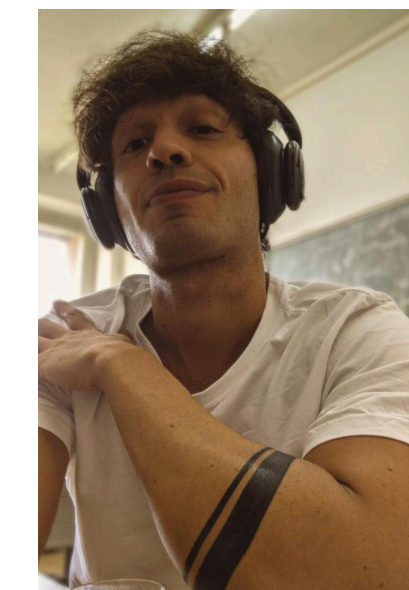
"Axion theory and production in the early universe". Lecturer: Kiwoon Choi (IBS, Daejeon). Trainer: Nicole Righi (King's College, London)

"Axion cosmology and cosmo bounds". Lecturer: Ciaran O'Hare (Sidney Univ.). Trainer: Mathieu Kaltschmidt (Zaragoza Univ.)

"WISPs from stars". Lecturer: Georg Raffelt (MPI, Munich). Trainer: Andrea Caputo (CERN)

"Axion experiments". Lecturer: Giuseppe Ruoso (INFN, Padua). Trainer: Antonios Gardikiotis (Patras Univ.)

"Topics in science communication". Lecturer: Giuliana Galati (Bari Univ.)



Objective: "Attract young talented researchers from all over the world towards the activities of the Action through training activities"

Planning ahead

- Organization of dedicated seminars on specific topics, intended to be more “on-hands”, very practical talks.

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Ex. Seminar on the use of MESA for BSM physics (Speakers may include Jeremy Sakstein or Maurizio Giannotti)

We welcome suggestions and ideas, write to us!

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We welcome suggestions and ideas, write to us!

- Creation of a useful data repository (this is one of the important **deliverables!**)

Objective: “Develop a common database on WISPs theoretical models, experimental and astrophysical bounds”

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Supernova Models
White Dwarfs, Red Giants profiles
Galactic and Extragalactic magnetic field configurations
Axions, Dark Photons, Scalars emission rates
Etc, etc.

- Organization of dedicated seminars on specific topics, intended to be more “on-hands”, very practical talks.

Ex. Seminar on the use of MESA for BSM physics (Speakers may include Jeremy Sakstein or Maurizio Giannotti)

- Creation of important c

Ex. These nice Github repositories by S. Hoof and C. O’Hare, members of the Action!

Solar Axion Flux

A C++ library to calculate the expected flux from axion-photon and axion-nucleon interactions inside the Sun

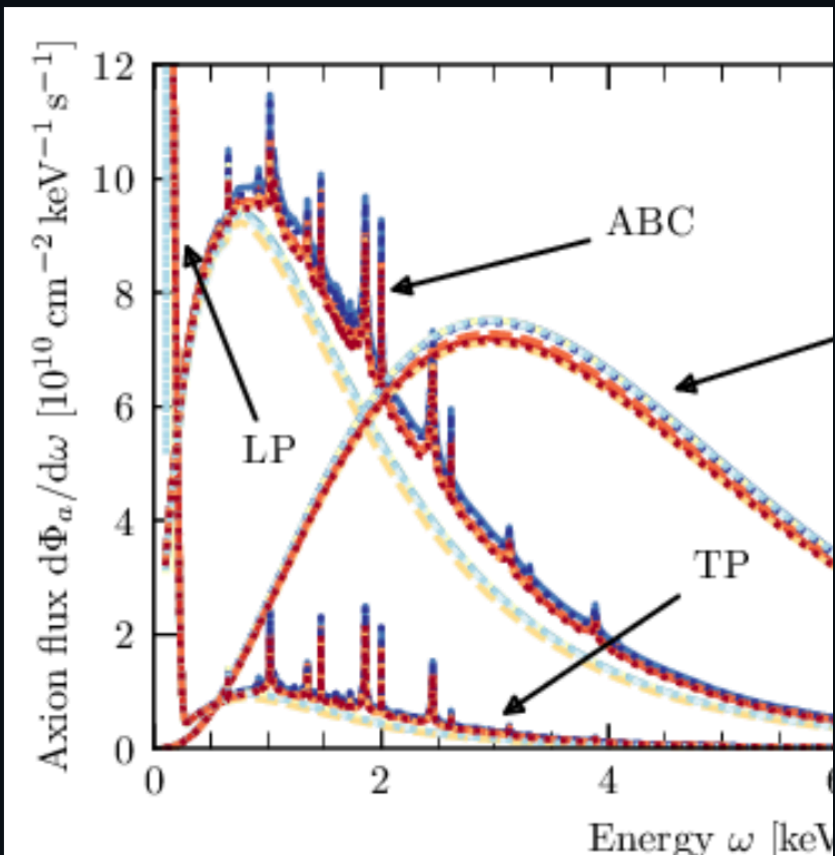
Developers: [Sebastian Hoof](#) and [Lennert Thormaehlen](#)

Information on how to acknowledge this work in the literature can be found [here](#)

This code has been published under the BSD 3-clause license. Contributions are welcome

Example results

We use the code for our study on “Quantifying uncertainties in the solar axion model parameters.” The published paper can be found at [JCAP](#). Calculations of the axion flux from nuclear transitions were added last year and are available on the arXiv [arXiv:2111.06407](#).



Axion-photon coupling

Basic plot

[View Notebook \(.ipynb\)](#)

[Download \(.pdf\)](#)

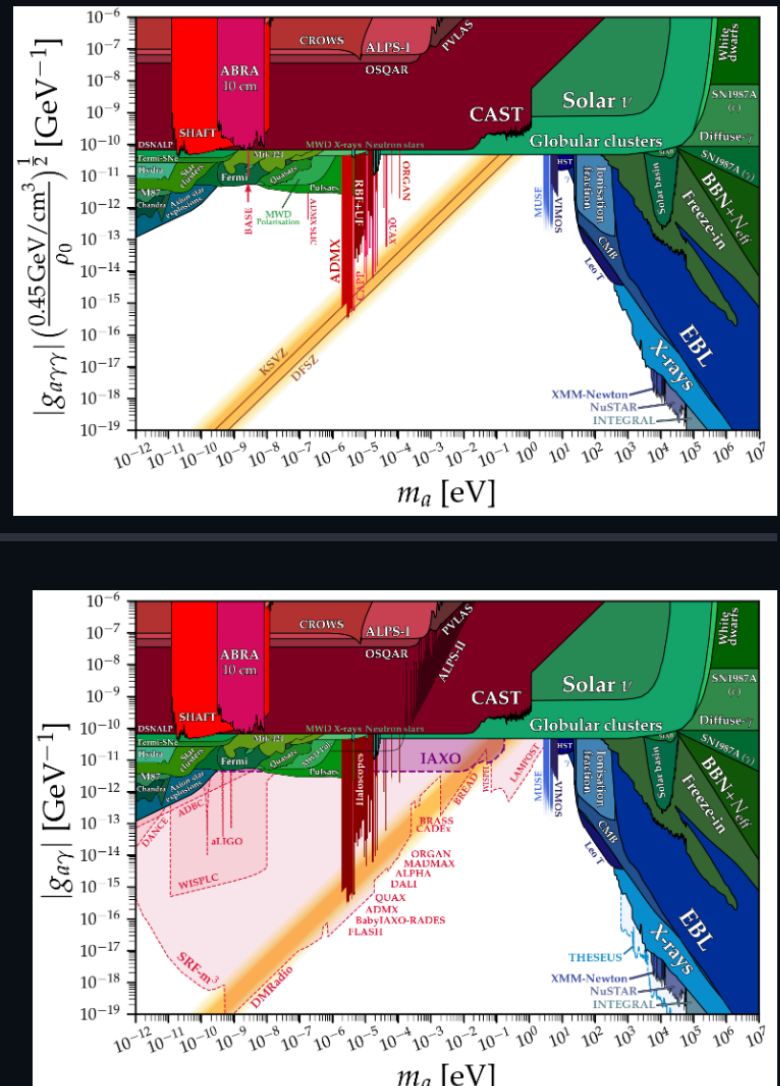
[Download \(.png\)](#)

Basic plot with projections

[View Notebook \(.ipynb\)](#)

[Download \(.pdf\)](#)

[Download \(.png\)](#)



- Organization of dedicated seminars on specific topics, intended to be more “on-hands”, very practical talks.

Ex. Seminar on the use of MESA for BSM physics (Speakers may include Jeremy Sakstein or Maurizio Giannotti)

- Creation of a useful data repository (this is one of the important **deliverables!**)
- Organization for next year of **topical** mini-schools or workshop (in collaboration with WG2)

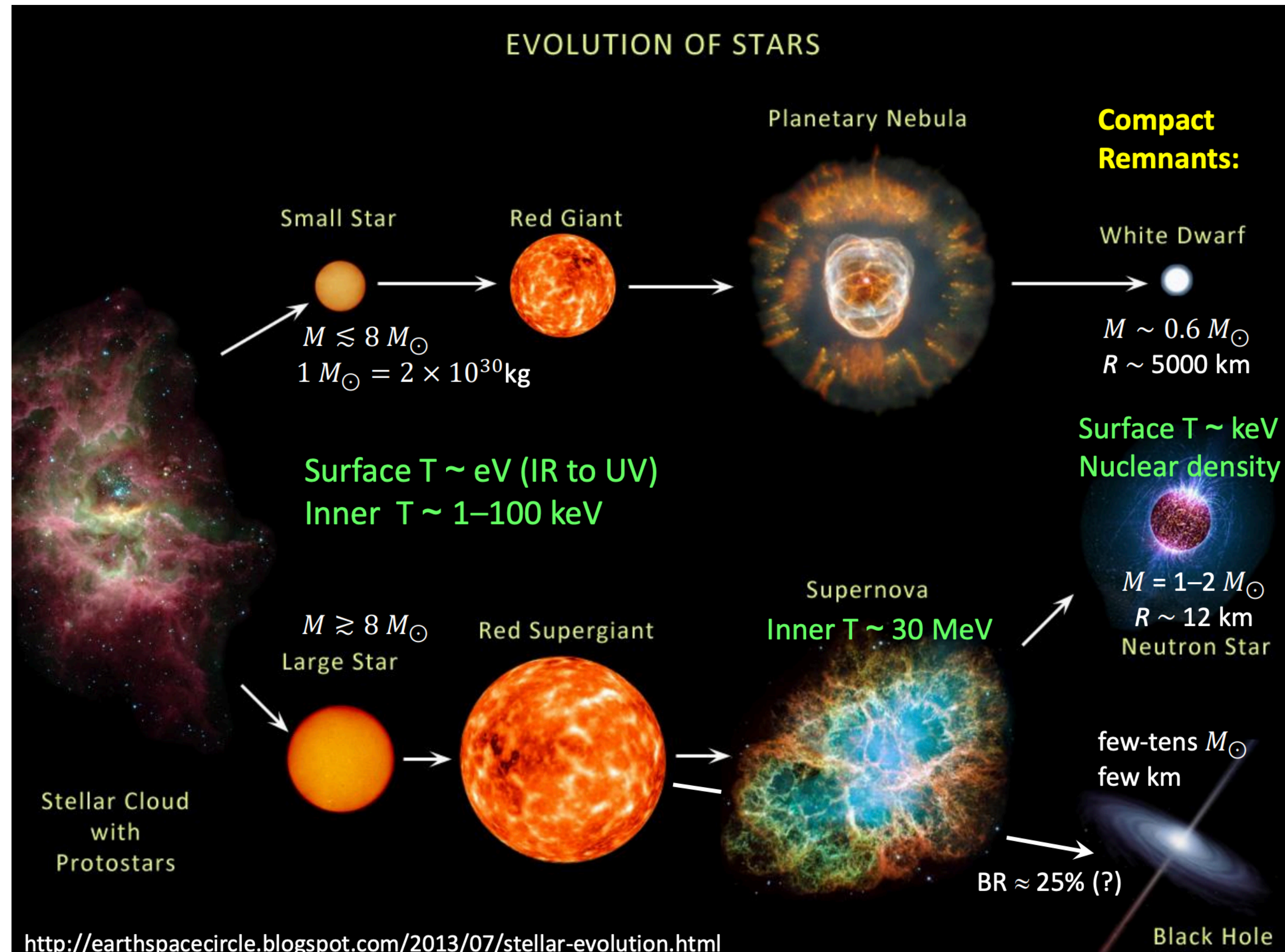
Ex. Mini-school for the use of MESA and/or SN models (at least in their simplified 1D realisations) for BSM physics

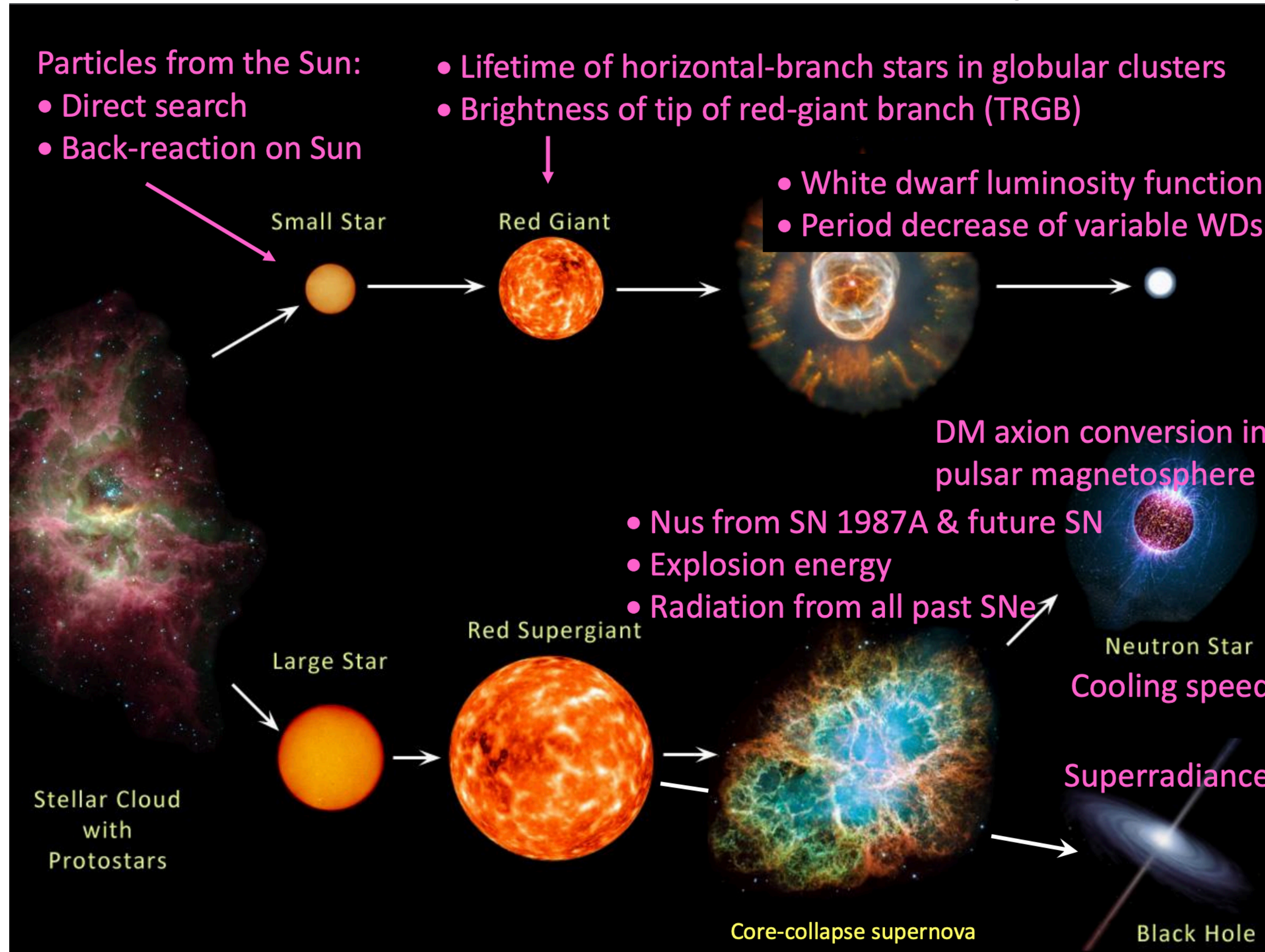
Outreach!



Some physics

(Sorry, I love doing physics, couldn't help to put some)





We get published in the best journals of the field!

Credit to Georg Raffelt, DESY Colloquium 2022

Particles from the Sun:

- Direct search
- Back-reaction on Sun

- Lifetime of horizontal-branch stars in globular clusters
- Brightness of tip of red-giant branch (TRGB)

- White dwarf luminosity function
- Period decrease of variable WDs

Physics ABOUT BROWSE PRESS COLLECTIONS Search articles

SYNOPSIS

Hunting for Axions in the Galactic Center

December 13, 2022 • Physics 15, s163

A neutron star's ultrastrong magnetic field could create the conditions for unclocking a promising dark matter candidate.

I. Heywood/University of Oxford; SARAO; J. C. Muñoz-Mateos/ESO

Sam Witte and collaborators

with Protostars

Small Star

Red Giant



Red Supergiant

Large Star



DM axion conversion in pulsar magnetosphere

- Nus from SN 1987A & future SN
- Explosion energy

Open Access

Constraining Heavy Axionlike Particles by Energy Deposition in Globular Cluster Stars

Giuseppe Lucente, Oscar Straniero, Pierluca Carenza, Maurizio Giannotti, and Alessandro Mirizzi
Phys. Rev. Lett. **129**, 011101 – Published 29 June 2022

supernovae

Low-Energy Supernovae Severely Constrain Radiative Particle Decays

Andrea Caputo, Hans-Thomas Janka, Georg Raffelt, and Edoardo Vitagliano
Phys. Rev. Lett. **128**, 221103 – Published 3 June 2022

We also win important grants!

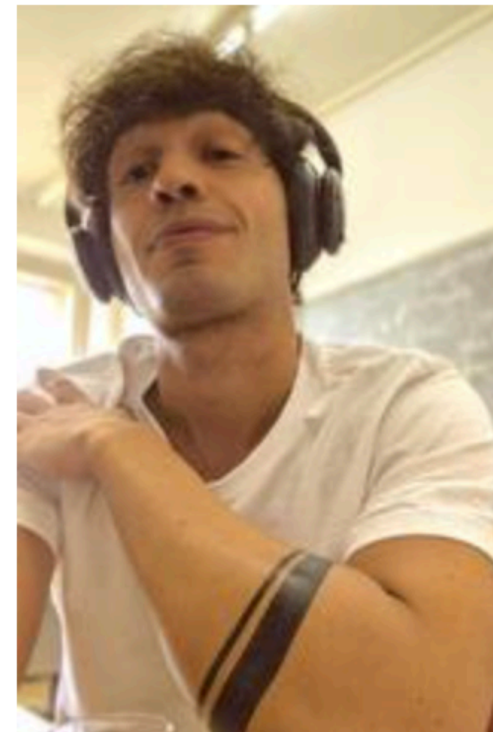
ERC Starting Grant!

Caputo's AstroDarkLS project focuses on the search for the mysterious Dark Matter. According to cosmological studies, Dark Matter is more than five times more abundant in the universe than the matter we are familiar with, and which is described by the so-called Standard Model of particle physics. "The Standard Model is a successful and well-verified theory," Caputo explains. "However, there are still many open questions, such as the origin of neutrino masses and the nature of Dark Matter and Dark Energy. The need for physics beyond the Standard Model is undeniable, but the question is: How and where will we find it?"

In search of an answer to this question, the project is studying the impact of hypothetical light Dark Matter particles on a series of astrophysical and cosmological phenomena in order to identify a possible signature of these particles. "Our hope is to discover Dark Matter or at least unveil some of the mysteries of the 'dark sector'," Caputo says.

In total, the ERC has awarded 400 Starting Grants totaling 628 million euros to young researchers from across Europe. The funding is part of the EU's Horizon Europe program. Almost 2700 scientists applied for the grants. Among the successful applicants, the proportion of women is particularly high this year at 43 percent, according to the ERC.

"It is part of our mission to give early-career talent the independence to pursue ambitious curiosity-driven research that can shape our future," emphasises ERC President Maria Leptin. "In this latest round of Starting Grants, we saw one of the highest shares of female grantees to date, which I hope will continue to rise. Congratulations to all winners and good luck on your path to discovery."



[Download \[103KB, 959 x 1422\]](#)
Andrea Caputo. Credit: Andrea Caputo

Another COST Action!

CA22130 - Comprehensive Multiboson Experiment-Theory Action (COMETA)

Downloads

[Home](#) > [Browse Actions](#) > Comprehensive Multiboson Experiment-Theory Action (COMETA)

Description

Management Committee

Main Contacts and Leadership

Working Groups and Membership

Main Contacts

Action Contacts



Prof Iliaria BRIVIO

Main Proposer

+393318908534

ilaria.brivio@unibo.it



Action Details

MoU - 04/23

CSO Approval date - 12/05/2023

Start date - 18/09/2023

End date - 17/09/2027

How can I participate?

- Read the Project Description [MoU](#)
- Inform the Main Proposer/Chair of your interest ([email](#))
- [Apply](#) to join your Working Groups of interest

What can we expect?

- Search for solar axions
- Extension & refinements of existing arguments
- Search for magnetically converted ALPs
- Radio search for axion dark matter conversion in neutron star magnetospheres
- Next galactic supernova observation
- Gravitational-wave evidence for superradiance from black holes

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- Next galactic supernova observation
- Gravitational-wave evidence for superradiance from black holes
- New, out of the box ideas

Thank you for the attention

