COSPA Theory@ULB

Laura Lopez Honorez . Alain Jorissen . Peter Tiniakov

on behalf of the ULB theory groups

Staff members invoved in Cospa

IAA
Institut d'Astronomie et d'Astrophysique

N . Chamel

L. Siess

S. Goriely

D. Pourbaix

A. Jorissen

S. Van Eck

PTM
Service de Physique Theorique & Mathematique

G. Compère

PHYSTH
Service de Physique Theorique

S. Clesse

T. Hambye

L. Lopez Honorez

P. Tinyakov

M. Tytgat

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Interest and expertise
Cospa

IAA: nuclear astrophysics, nucleosynthesis, stellar structure and evolution, stellar abundances and radiative transfer, binary stars, (astro)physics of compact stars, neutron stars, kilonovae, ESA Gaia satellite

PTM: GR, BH, GW, waveforms generation, Radiation/Bondi formalism, Post-Minkowskian formalism, Dark matter and accretion disks effects on waveforms, Black hole ringing

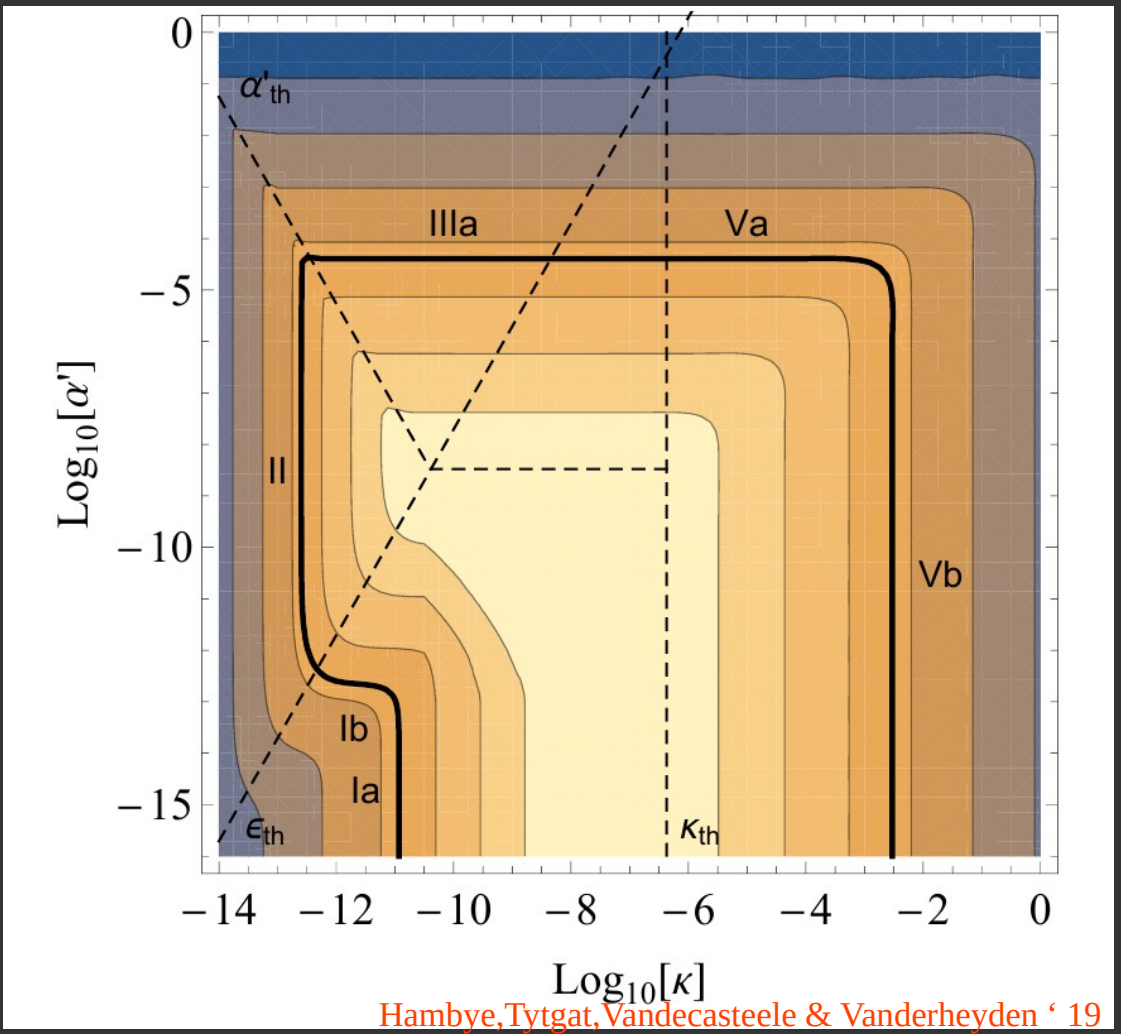
PHYSTH: Leptogenesis, baryogenesis, dark matter, BSM, cosmology, neutrino masses and magnetic moment, symmetry breaking, baryonic asymmetry, High energy cosmic rays and Telescope array, 21 cm, gravitational waves, extra dimensions, modified gravity, Primordial Black Holes, inflation, dark energy.

Cospa@PHYSTH

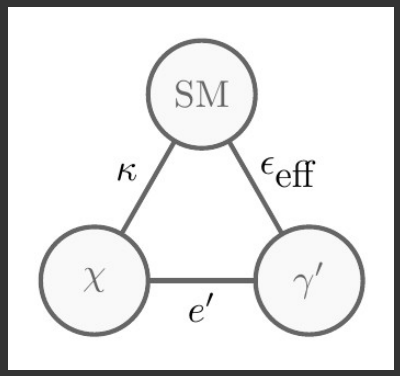
DM, BSM,PBH,Inflation, neutrinos, finite T QFT

M. Tytgat

- Building of dark matter models (based on Lagrangians and symmetries)
- Study of DM production mechanism for the DM particle
- Study of possible DM signatures and constraints



Hambye,Tytgat,Vandecasteele & Vanderheyden ' 19



Other interests :

- Physics of primordial black holes
- Models for inflation
- Neutrino physics
- Lepto and baryogenesis
- Finite temperature and finite density quantum field theory

Cospa@PHYSTH

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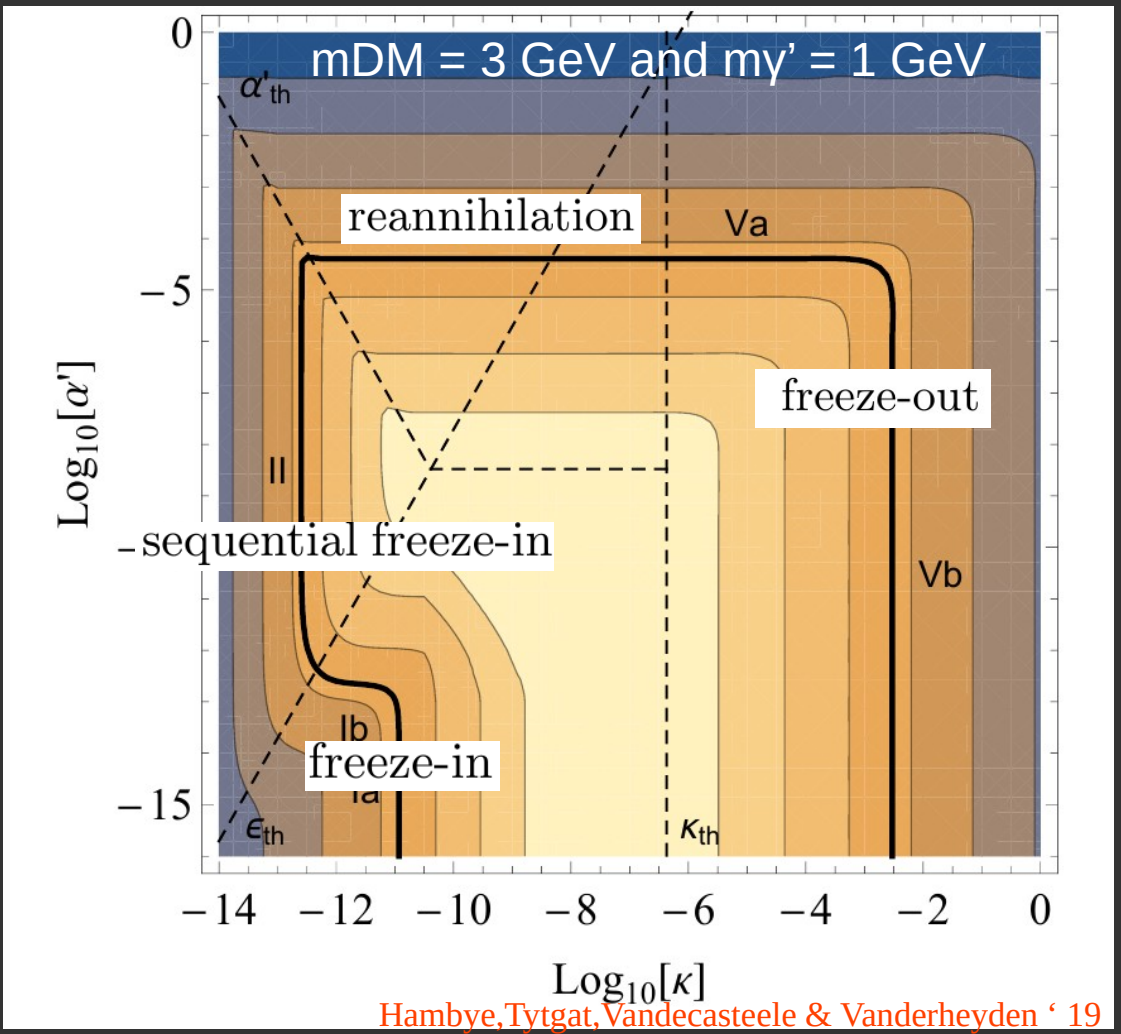
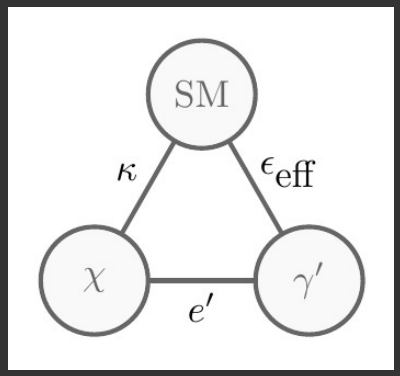


Hambye,Tytgat,Vandecasteele & Vanderheyden ' 19



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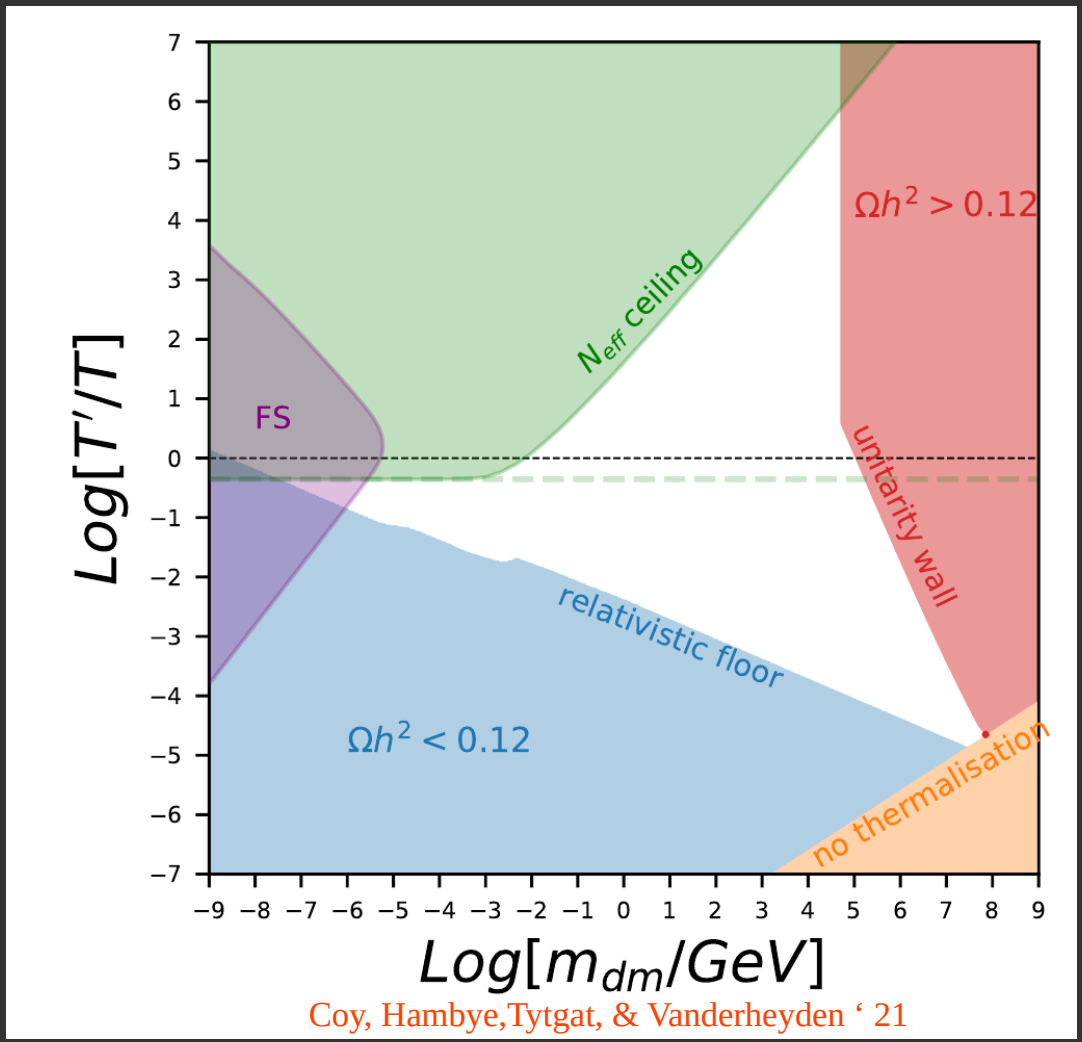
Cospa@PHYSTH

DM, Baryon asym, neutrino, origin of EWSB, GUT

T. Hambye

Dark Matter particle:

- Particle physics model building, BSM, and exp/cosmo constraints
- Dark matter production short after Big Bang
- Dark matter in neutron stars



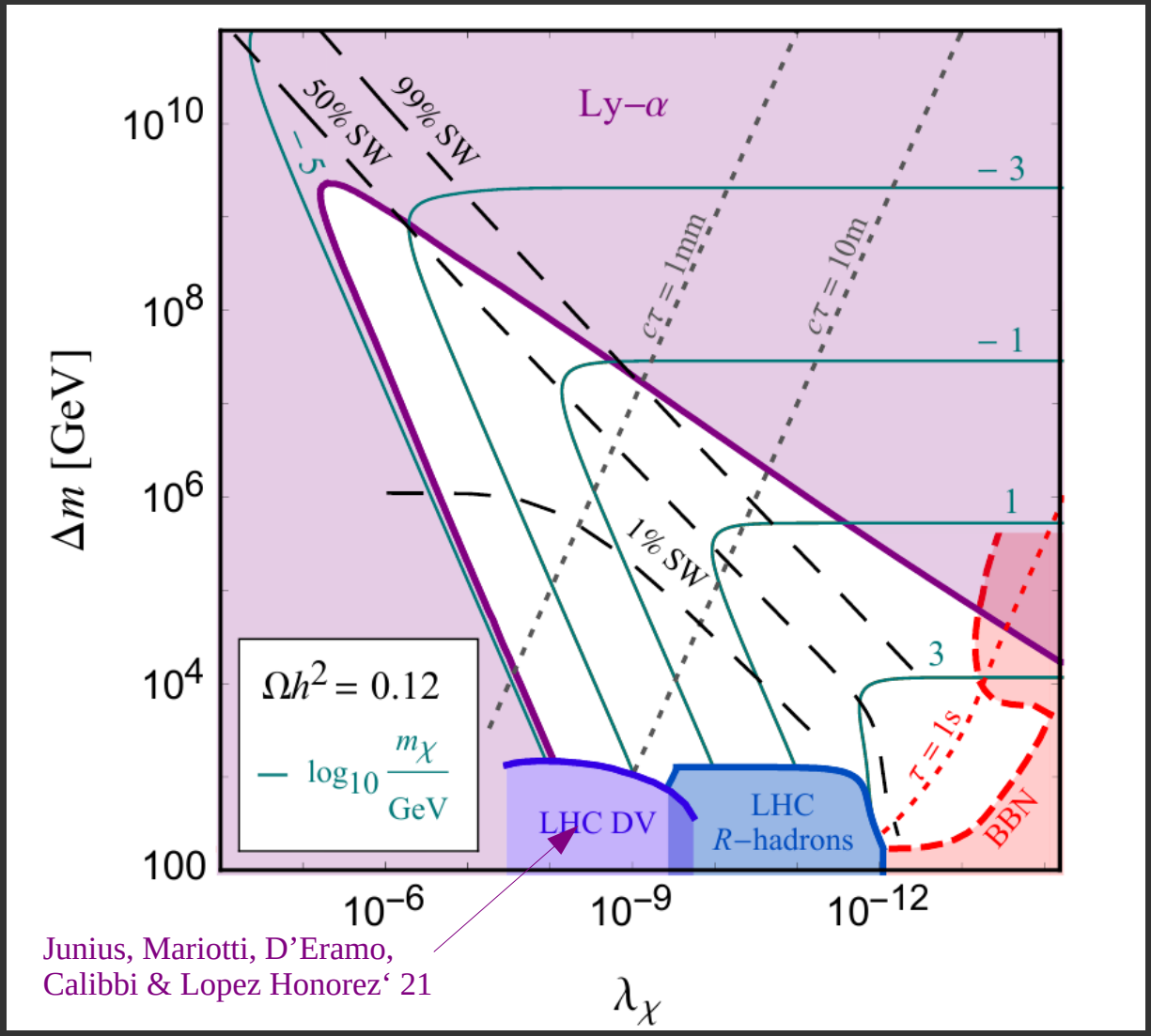
Coy, Hambye,Tytgat, & Vanderheyden ' 21

- Origin of matter-antimatter asymmetry in Universe :
  - new explanation mechanisms
  - Connection with origin of neutrino masses : leptogenesis
- Neutrino physics
  Origin of neutrino masses, tests, connections with Dark Matter, ...
  IceCube, …
- Origin of electroweak symmetry breaking, Grand-Unification, ...

L. Lopez Honorez

Cospa@PHYSTH
DM cosmo & particle, DE, 21cm

Decant, Heisig, Hooper & Lopez Honorez to appear ' 21



Junius, Mariotti, D'Eramo, Calibbi & Lopez Honorez' 21

Dark Matter particle

- DM production mechanisms in the early universe
- Detection at colliders, indirect, direct, etc

Cosmo & DM

- DM imprint on structures, reionisation, CMB, 21cm
- DM-DE interations, models and imprint on cosmo observables
- DM from PBH evaporation

Cospa@IAA

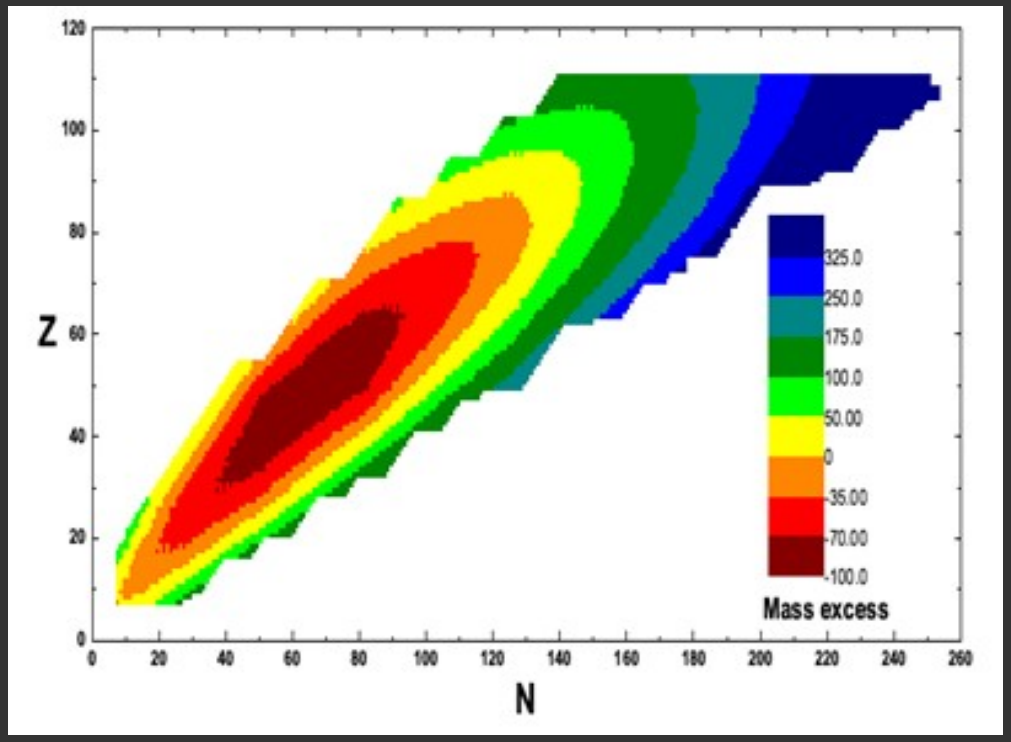
Nucleosynthesis and nuclear astrophysics

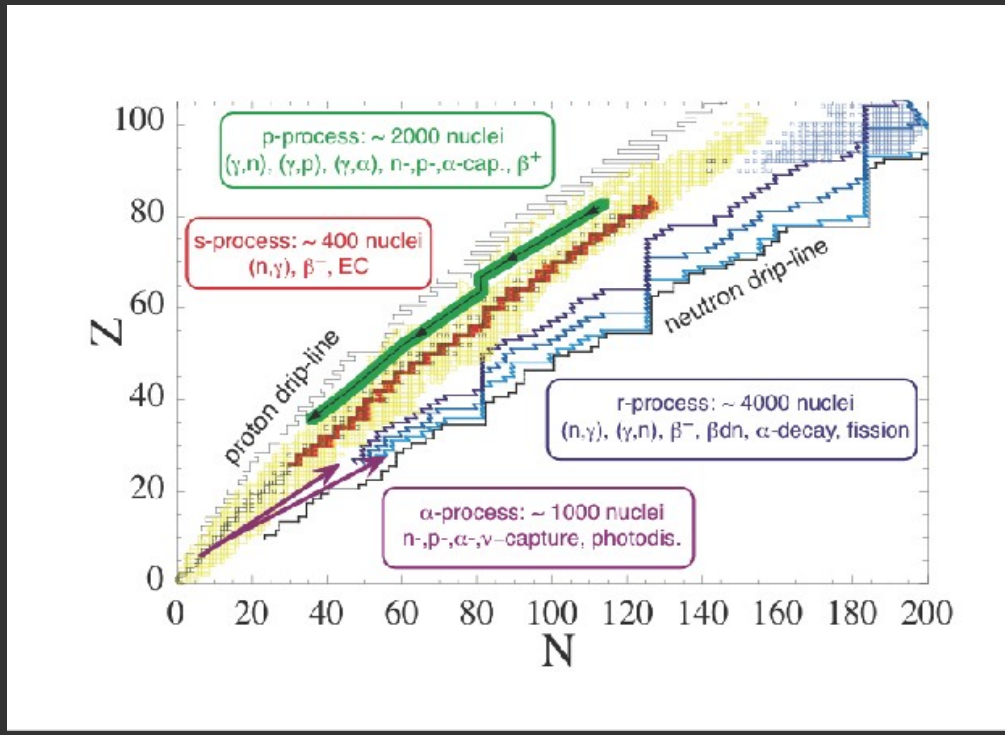
S. Goriely

Calculations of nuclear data of astrophysical / nucleosynthesis interest

Heavy element formation by s, r, p processes in the final stages of stellar evolution

Kilonova nucleosynthesis

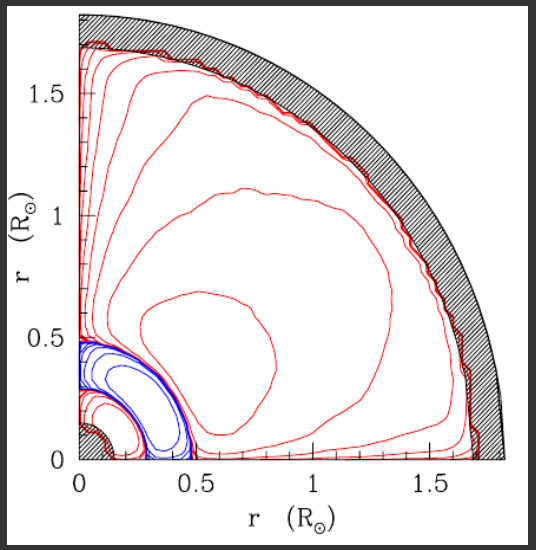




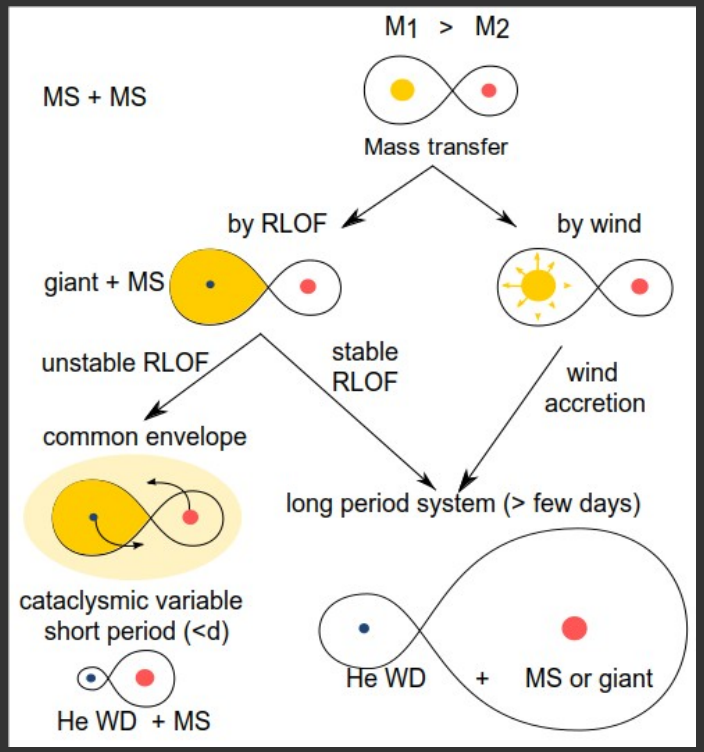
L. Siess

Cospa@IAA

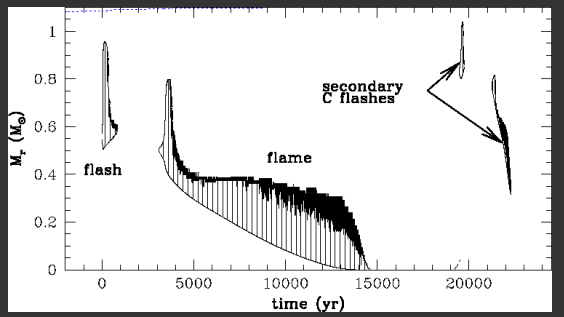
Stellar evolution, binary systems hydrodynamical simulations



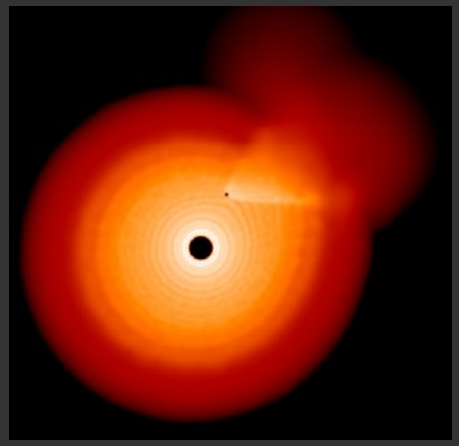
Rotationally induced currents in a 1.5 Msun star



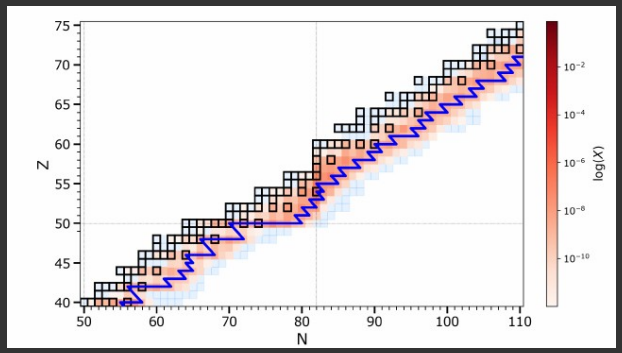
Evolutionary scenario for the formation of He white dwarf in long period binary



Degenerate carbon ignition in a 10 Msun star



3D simulation of wind mass transfer (SPH)



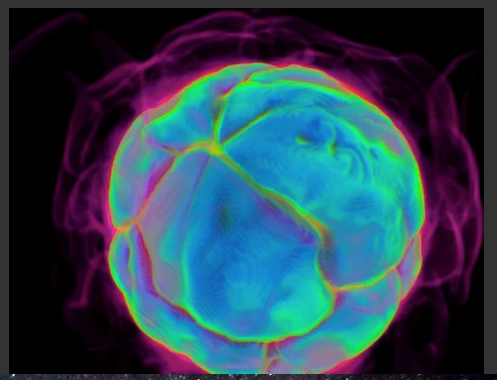
Heavy element nucleosynthesis

Cospa@IAA

Stellar atmospheres and abundances
HERMES spectrograph

S. Van Eck

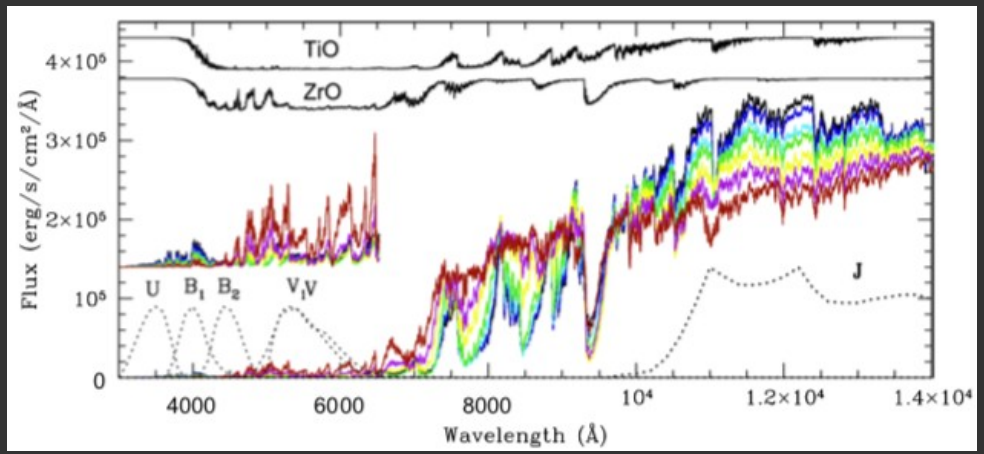
Stellar atmospheres: structure, computation, dynamics



Determination of chemical abundances in single and binary stars, and in evolved stars

Galactic archeology: chemical abundances in ancient stars

VLT, SALT, Gaia-ESO Survey



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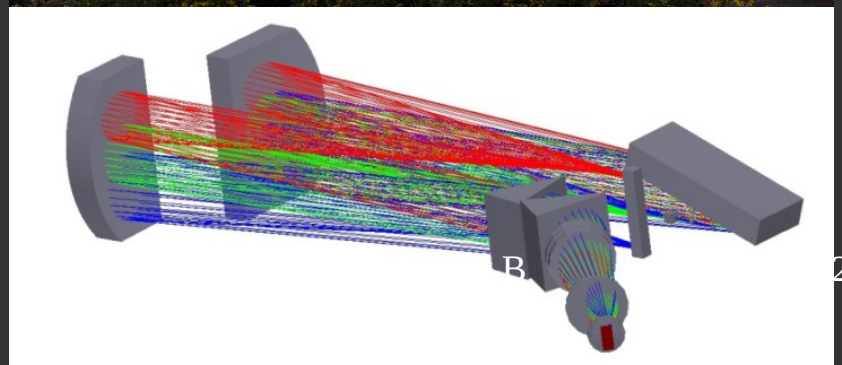
Binary and evolved stars, HERMES spectrograph

A. Jorissen

Dynamical evolution of multiple stellar systems

Long-term monitoring (HERMES) of radial velocities for investigating binarity among a wide range of stellar types

20 nights/year allocated to ULB-IAA



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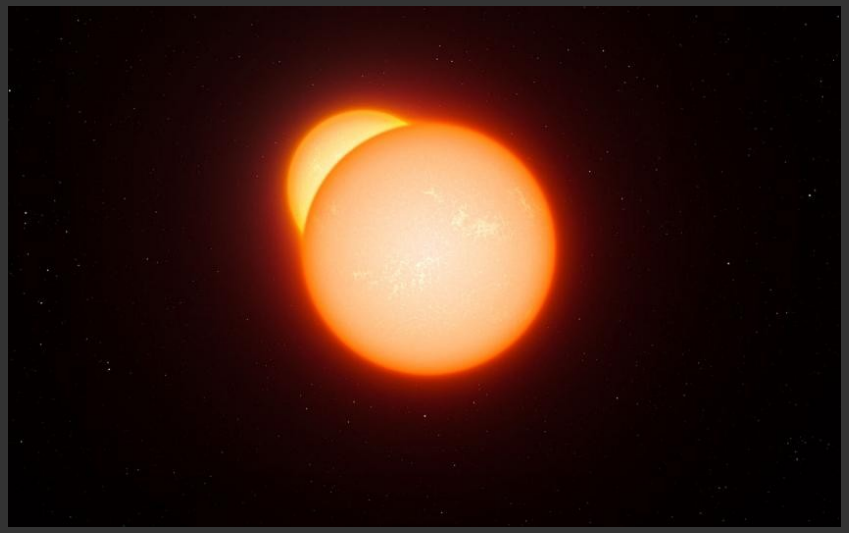
Gaia satellite and binary stars

D. Pourbaix

Astrometric orbits with Hipparcos and Gaia

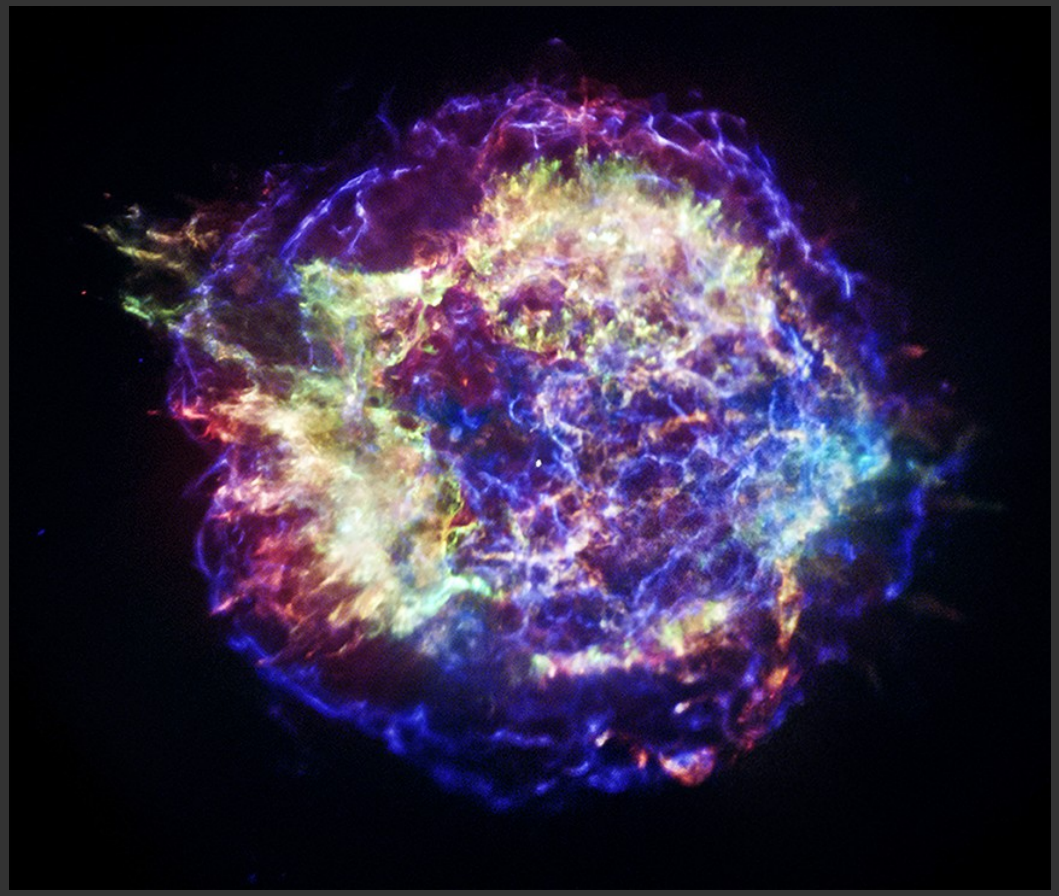
Modelling of light curves of eclipsing binaries

“Big data" astrophysical exploitation (10^9 stars)



Cospa@IAA
Compact stars

N . Chamel



Physics
- Equation of state
- Nuclear superfluidity, quantum vortices
- Hydrodynamics

Astrophysics
- Pulsar spin irregularities
- Magnetar outbursts
- Accreting neutron stars
- Binary inspirals, tidal deformations and gravitational waves

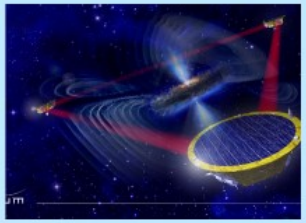
S. Clesse

Cospa@PHYSTH
PBH, DM, GW, 21cm

Gravitational-Waves

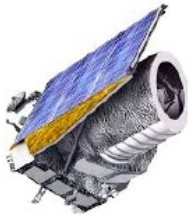
Ligo
Virgo
Kagra

Télescope
Einstein



LISA

LiteBird



Euclid

SKA

Cosmological Forecasts and Constraints

1. Primordial Black Holes: DM and GW signatures
- Search of subsolar-mass black holes
- Gravitational-wave background from PBHs
- Constraints on PBH models from GW observations
- PBH formation in numerical relativity, beyond spherical symmetry and constant equation-of-state
- PBH Review and numerical toolbox (LISA)
- Constraints on PBHs from continuous GWs
- High-frequency GW from PBHs

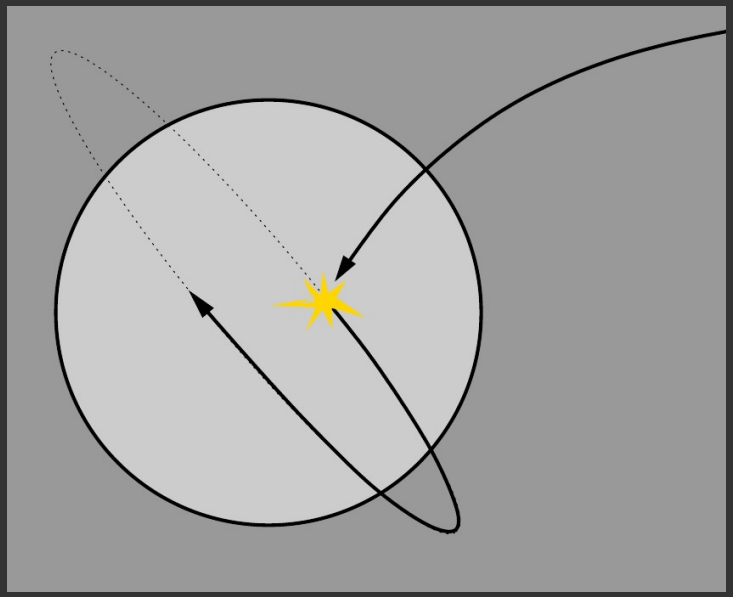
2. Forecasts and constraints on cosmological models
- Euclid/LiteBird forecasts inflation
- Euclid forecasts neutrinos masses, dark matter, Neff
- 21cm constraints on cosmological models (incl. PBHs)

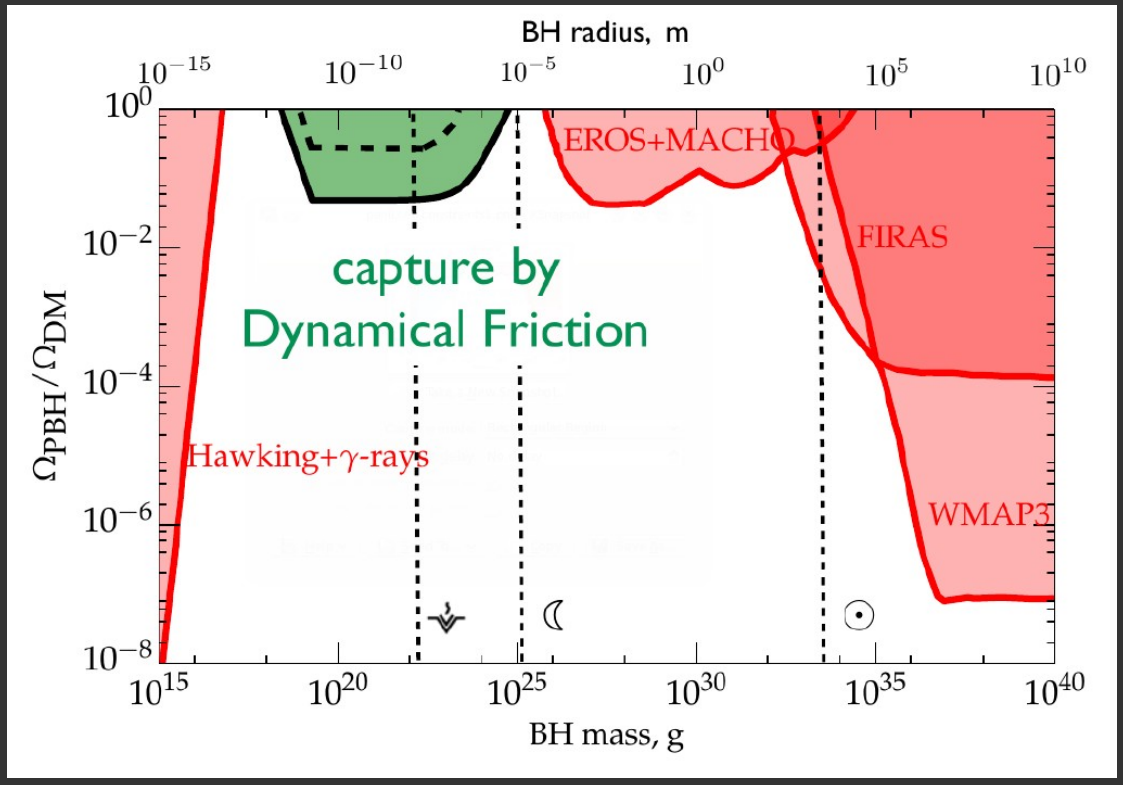
Cospa@PHYSTH

P. Tinyakov

Stars as Dark Matter detectors

- accumulation of DM in stars
- constraints on DM
- constraints on / detection of primordial Black Holes
- formation of BH from DM



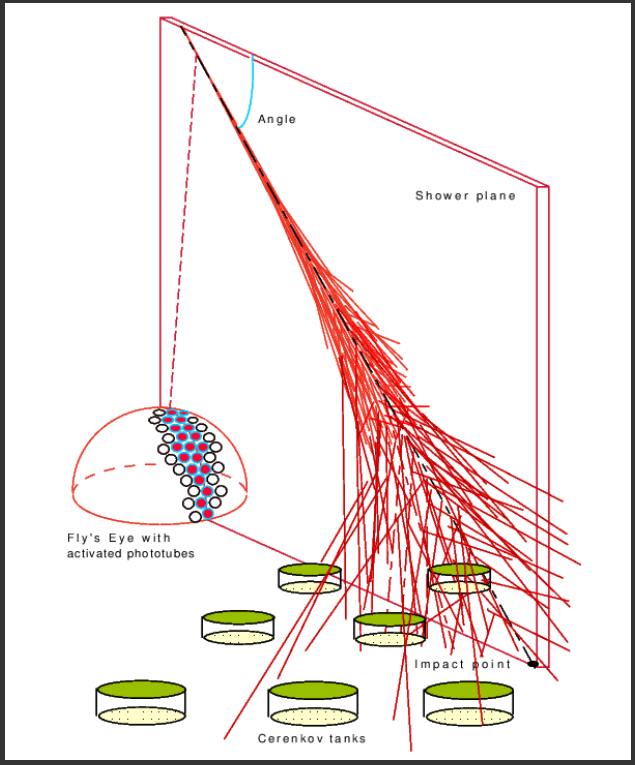


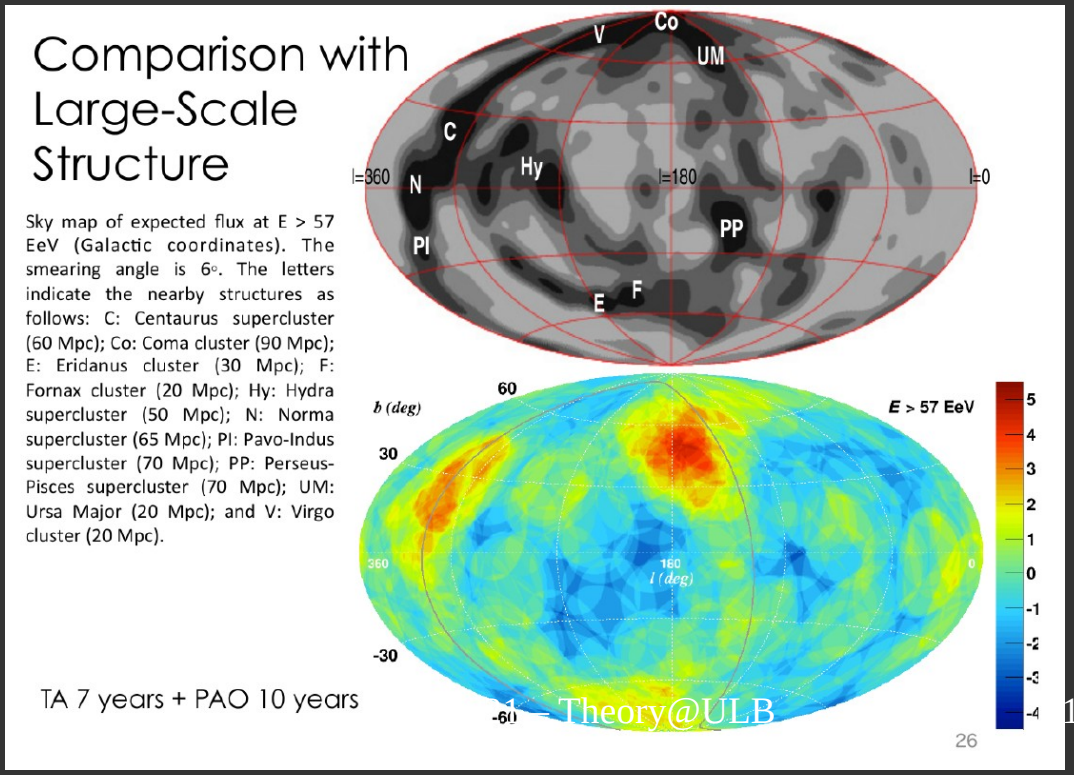
P. Tinyakov

Cospa@PHYSTH

Astrophysics of Ultra-High energy cosmic rays:

- anisotropies at large and small scales
- sources
- composition from arrival directions
- cosmic magnetic fields
- Telescope Array data interpretation





Cospa@PTM

G. Compère

- Two-body problem in GR
- Accretion into black holes
- Gravitational wave generation
- Transition from inspiral to merger
- Black hole imaging
- Resonances
- Highly spinning black holes
- Spin-coupling effects
- Fast waveform generation

- Scalar self-force
- Kerr geodesic motion
- Spin effects on waveforms
- Memory effects
- Radiation/Bondi formalism
- Post-Minkowskian formalism
- Dark matter and accretion disks
- effects on waveforms
- Black hole ringing

Conclusions

Large expertise in Cos-astro-pa in Theory@ULB!

IAA: nuclear astrophysics, nucleosynthesis, stellar structure and evolution, stellar abundances and radiative transfer, binary stars, (astro)physics of compact stars, neutron stars, kilonovae, ESA Gaia satellite

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Thank you !!