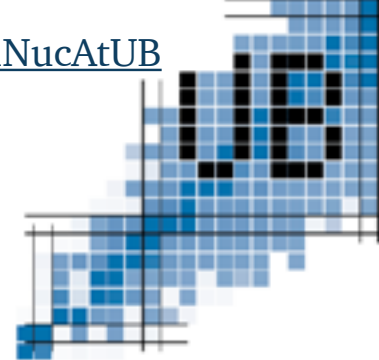




Hadron & Nuclear Physics at UB

<https://sites.google.com/fqa.ub.edu/hadnucatub/>

<https://icc.ub.edu/research/hadronic-nuclear-and-atomic-physics>



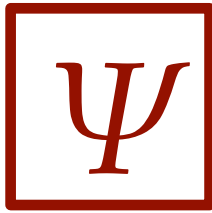
Arnau Rios Huguet

Associate Professor
Institute of Cosmos Sciences +
Universitat de Barcelona
arnau.rios@icc.ub.edu

President

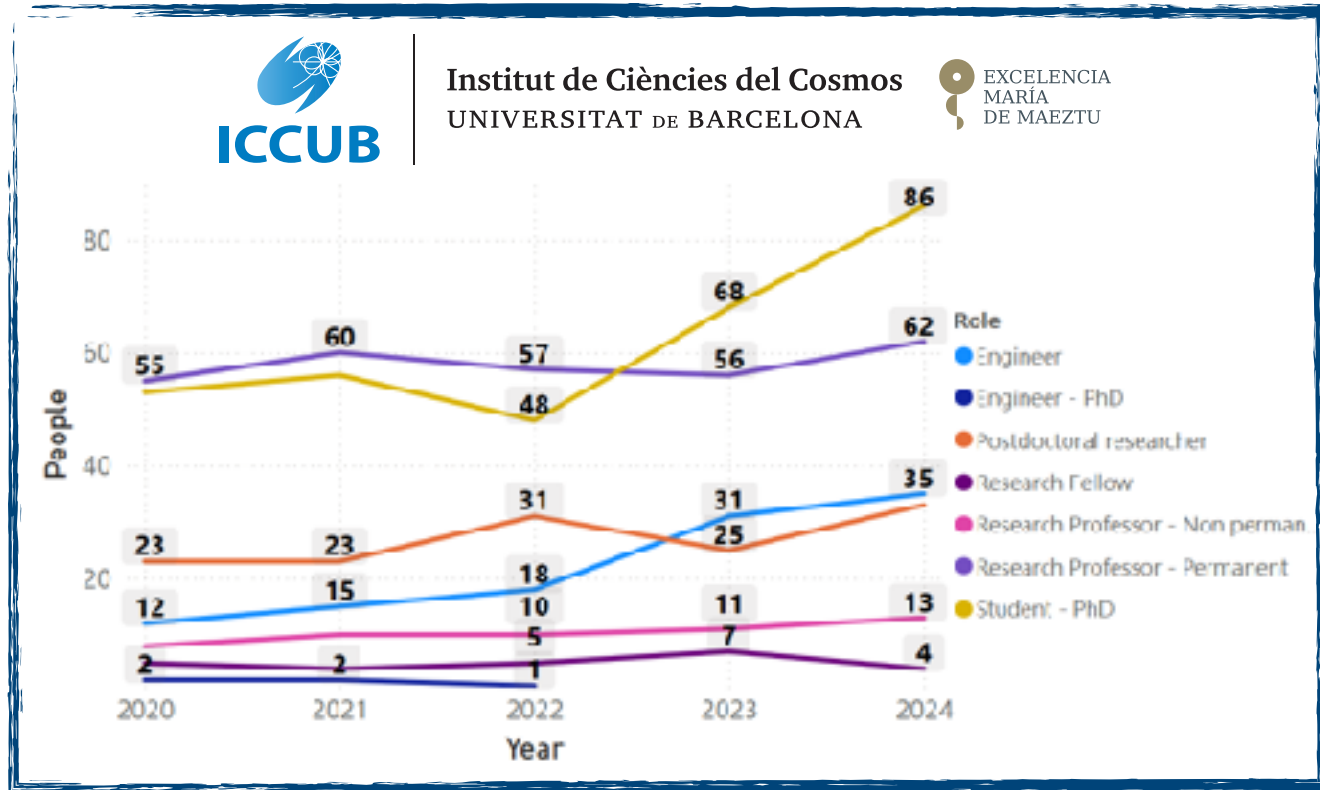
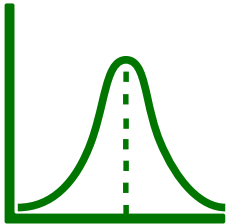


**NucPhys Career
Orientation Day**
14 November 2025



+

+



- Theoretical and computational research
- ICCUB group, access to mentorship schemes
- Longstanding PhD supervision experience
- Science outreach



Àngels Ramos

Full Professor



Assumpta Parreño

Full Professor



Volodya Magas

Associate Professor



Vincent Mathieu

Associate Professor



Juan Torres-Rincón

Associate Professor



Sergi González-Solís

Lecturer

Mario Centelles

Associate Professor



Javier Menéndez

Associate Professor



Arnau Rios

Associate Professor



Xavier Roca Maza

Beatriz-Galindo Researcher



Post-doctoral researchers

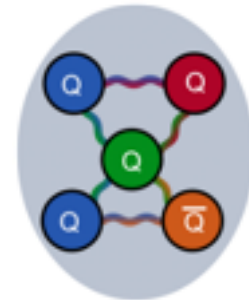
- Nadine Hammoud
- Glòria Montaña
- Alejandro Romero
- Emanuele Costa

Pre-doc researchers

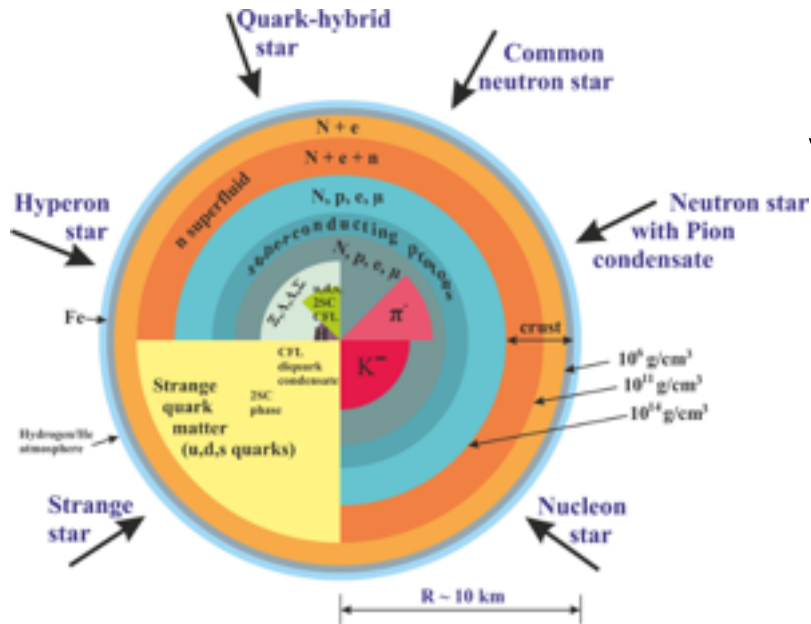
- Hristian Kochankovski
- Javier Rozalén
- Daniel Castillo
- Dorian Frycz
- Kerman Gallego
- Joan Ainaud

Fundamental questions in hadron physics

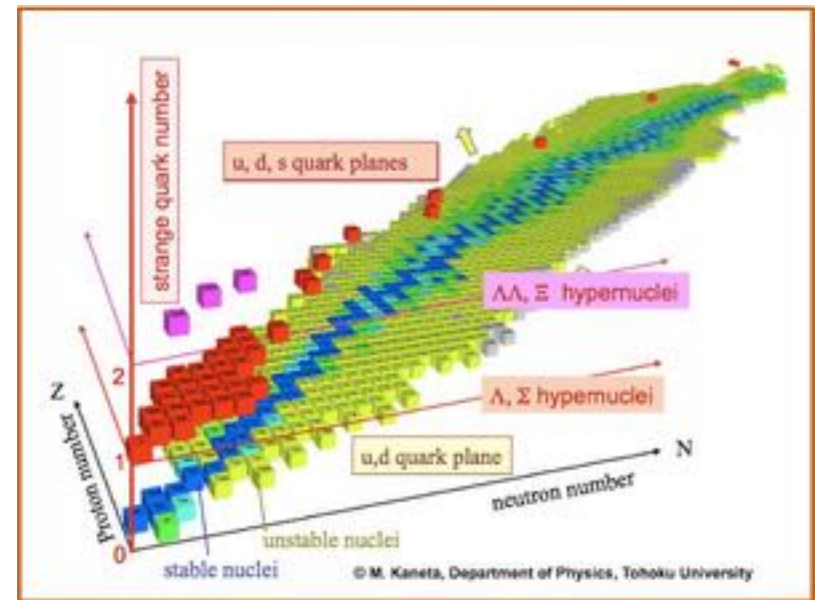
What are the properties of exotic states?



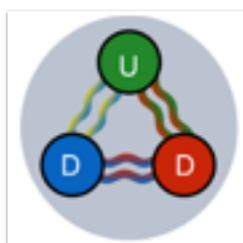
What role does strangeness play in neutron stars?



Can we understand hadrons, nuclei, nuclear matter from first principles (QCD)?

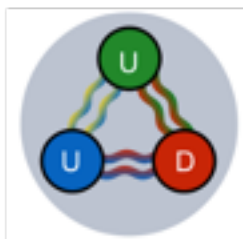


Ordinary and exotic hadrons



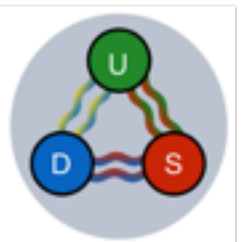
neutron

$$\tau \sim 10^3 s$$



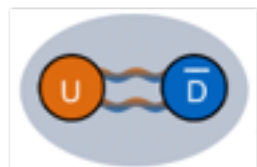
proton

stable

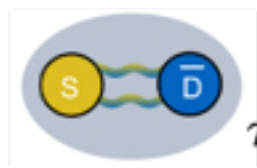
baryon Λ

$$\tau \sim 10^{-10} s$$

Ordinary mesons

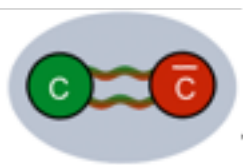
pion π

$$\tau \sim 10^{-8} s$$



kaon

$$\tau \sim 10^{-8} s$$

 J/ψ

$$\tau \sim 10^{-20} s$$

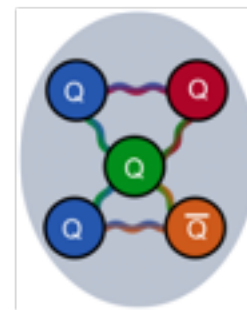
Exotic matter



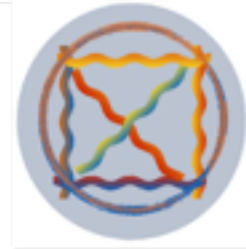
tetraquarks



hybrid mesons



pentaquarks



glueballs

QUARKS

UP
mass 2,3 MeV/c ²
charge 2/3
spin 1/2
u

CHARM
1,275 GeV/c ²
2/3
1/2
c

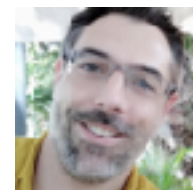
TOP
173,07 GeV/c ²
2/3
1/2
t

DOWN
4,8 MeV/c ²
-1/3
1/2
d

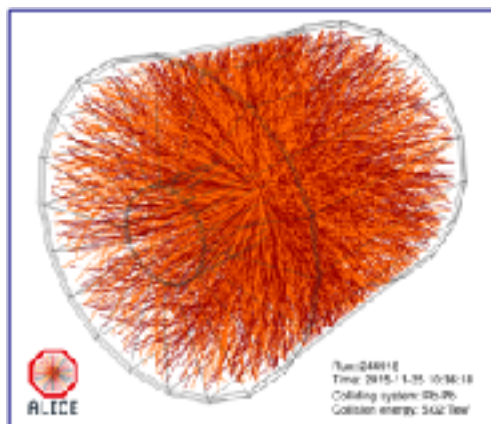
STRANGE
95 MeV/c ²
-1/3
1/2
s

BOTTOM
4,18 GeV/c ²
-1/3
1/2
b

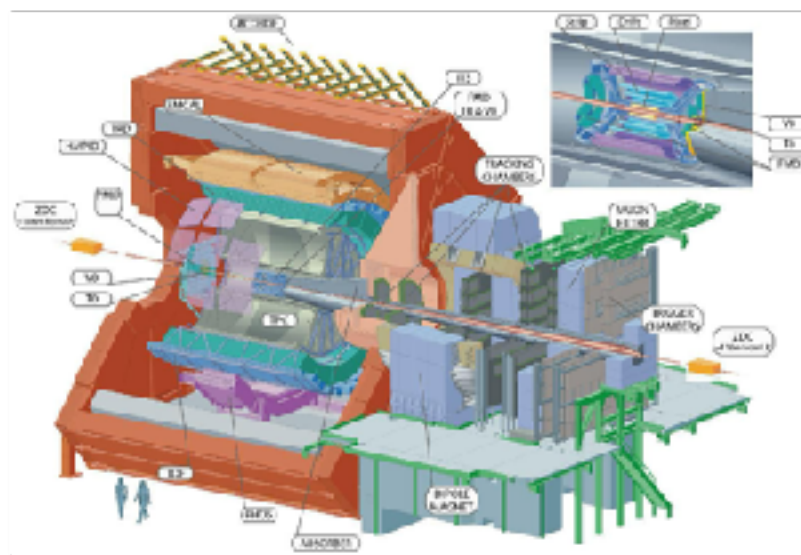
Vincent Mathieu



Heavy ion collisions

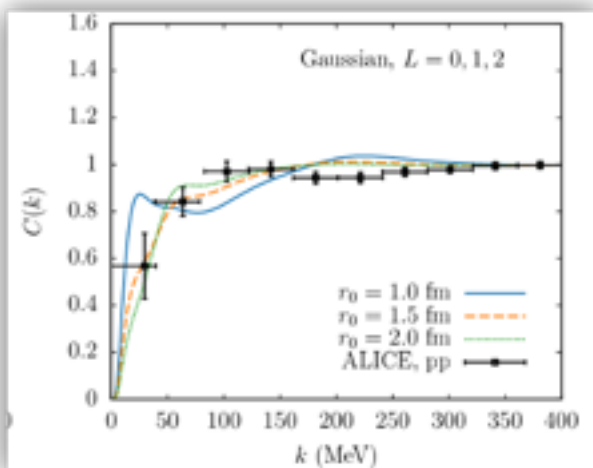


PbPb @
 $\sqrt{s_{NN}} = 5.02 \text{ TeV}$

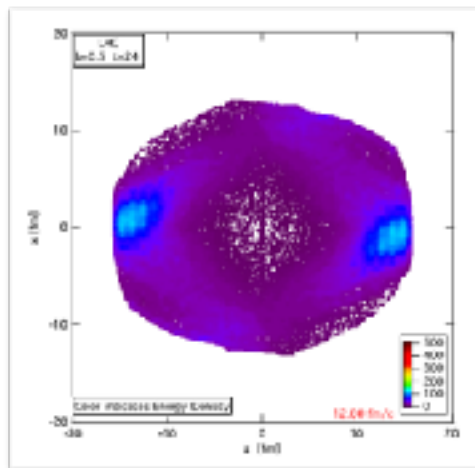


Experiment ALICE @ LHC (CERN)

Femtoscopy studies



Hydro simulations



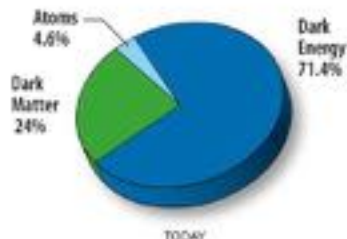
Volodya Magas

Juan Torres-Rincón

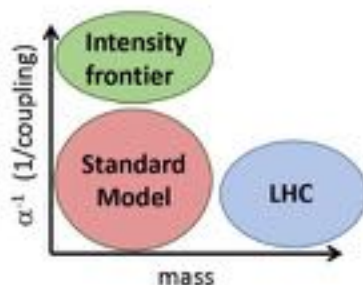


Searching for New Physics in Hadronic processes

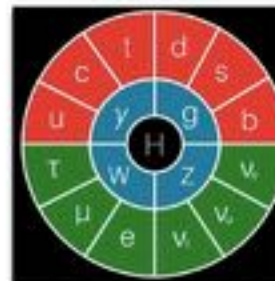
Evidence of New Physics!



Where is the New Physics?



Our visible universe



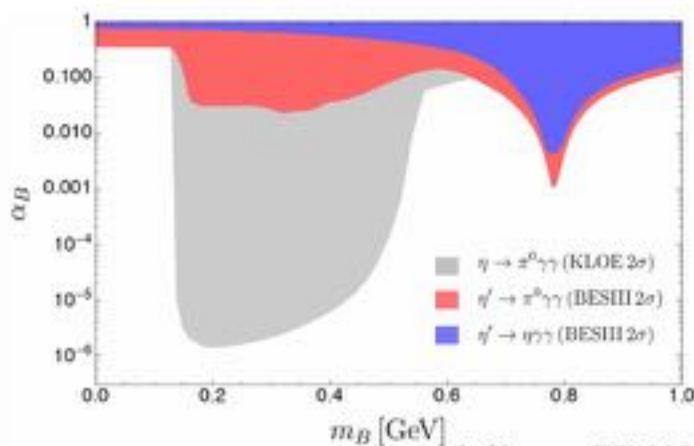
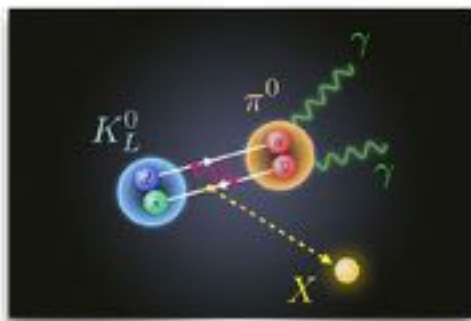
Portals



The dark universe



Imprints in rare meson decays: requires **Hadronic Physics** accurately predicted!



Worldwide experiments



sergig@fqa.ub.edu



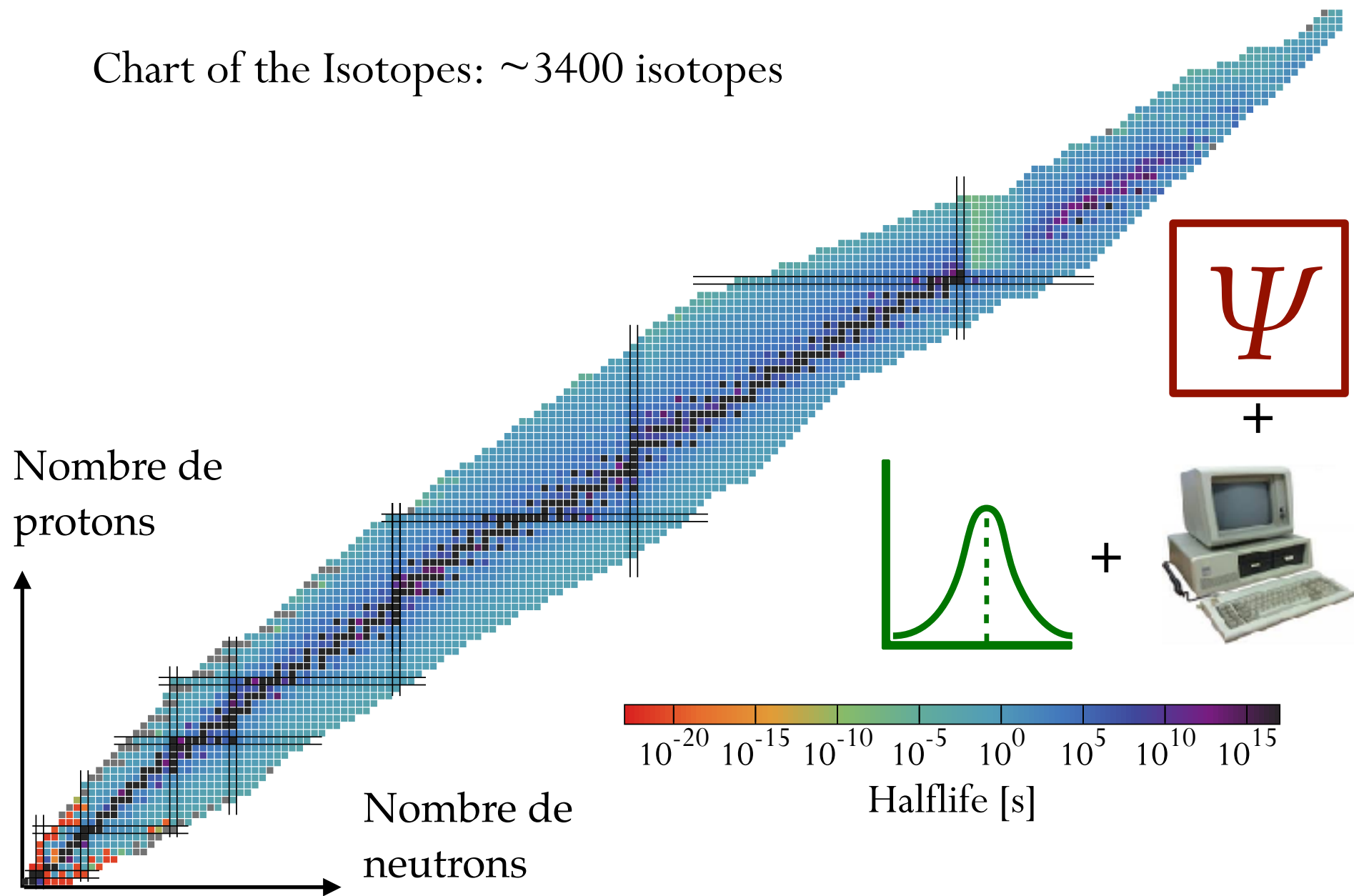
J. Clavero (TFM 23-24)

Branching ratios: $[10^{-10}, 10^{-5}]$

Sergi González-Solís

Segrè chart and theory

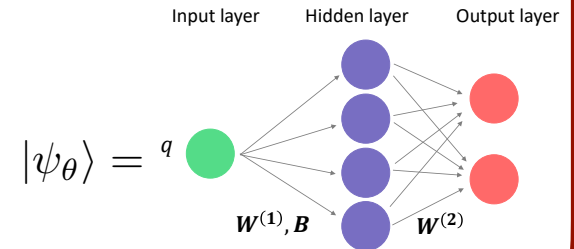
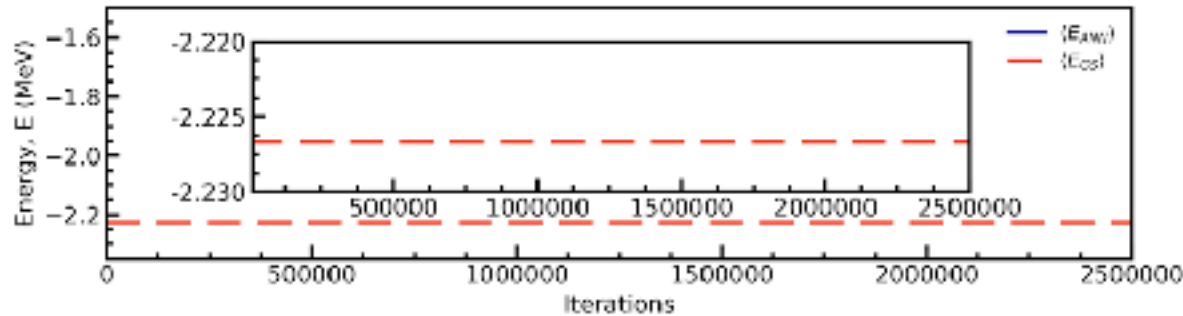
Chart of the Isotopes: ~ 3400 isotopes



AI & quantum computing nuclei

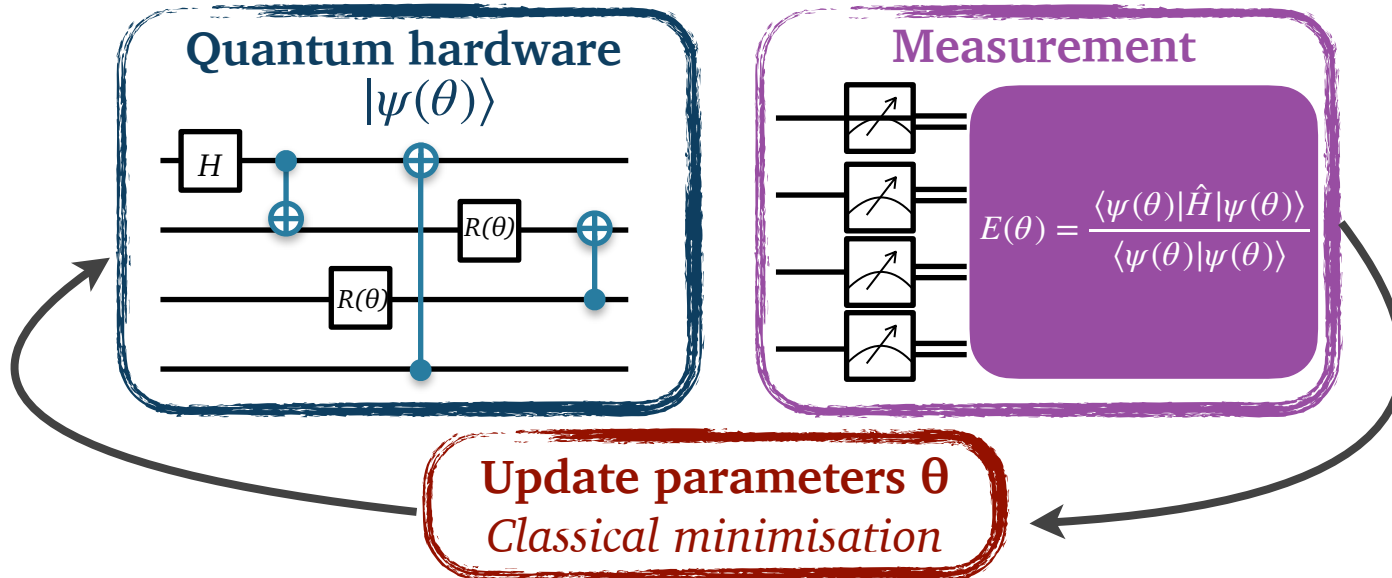
Neural Quantum States

$$E_{\theta} = \frac{\langle \psi_{\theta} | \hat{H} | \psi_{\theta} \rangle}{\langle \psi_{\theta} | \psi_{\theta} \rangle}$$



Keeble & Rios, Phys. Lett. B **809** 135743 (2020); J.W.T. Keeble, PhD Thesis; Keeble et al, Phys. Rev. A **108**, 063320 (2023)

Variational Quantum Eigensolver

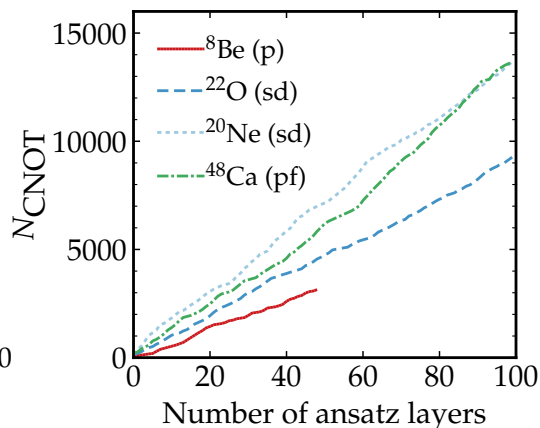
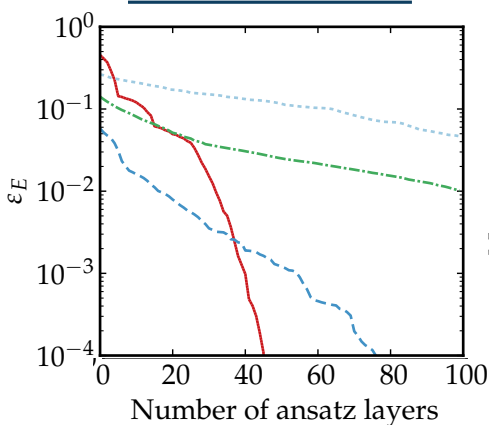


Pérez-Obiol et al. Scientific Reports **13**, 12291 (2023); EPJ A **59**, 240 (2023)



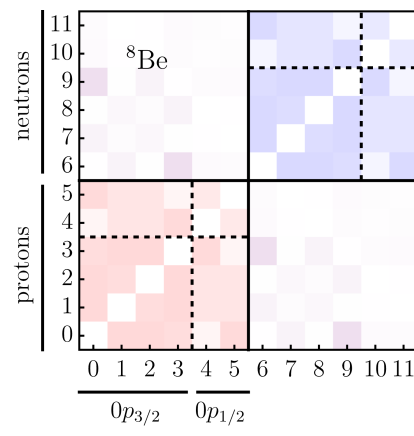
Results

Resources



Pérez-Obiol, Romero et al [Scientific Reports 13, 12291 \(2023\)](#)

Entanglement

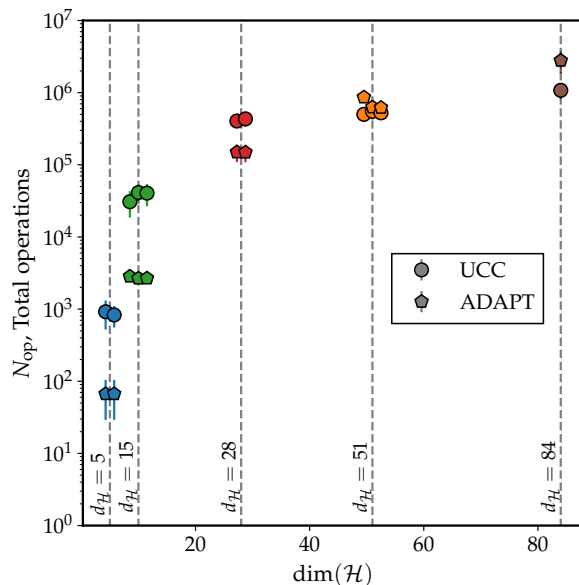


MareNostrum Ona
@BSC

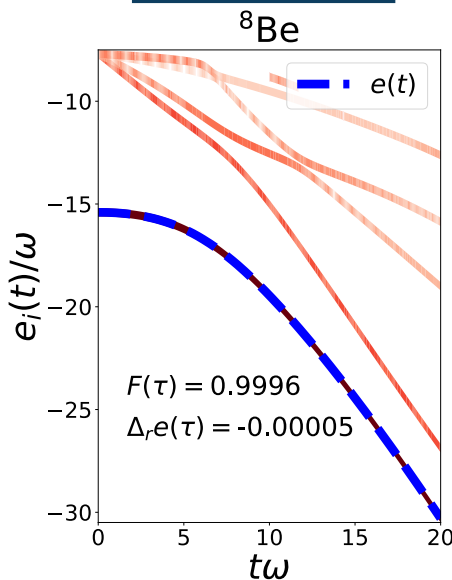


A. Pérez-Obiol, et al. [EPJA 59, 240 \(2023\)](#)

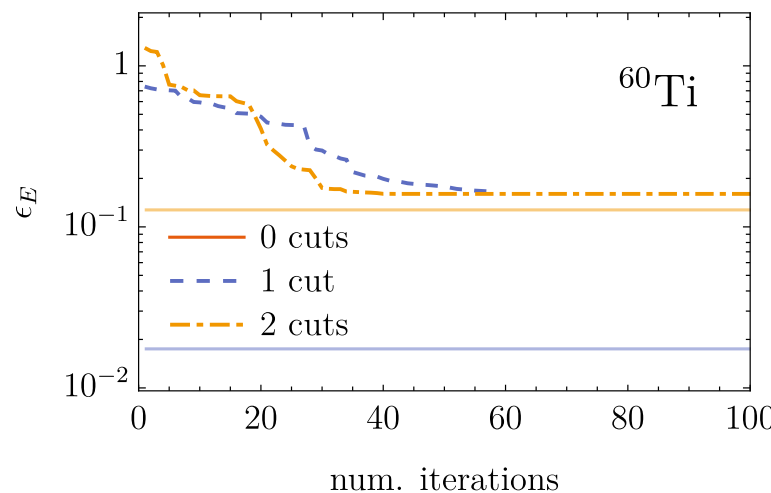
VQE comparisons



Adiabatic



Entanglement forging



Pérez-Obiol, Masot-Llima, et al,
[arXiv:2409.04510](#)

Costa et al., [arXiv:2411.06954](#)

10 Carrasco-Codina et al., [arXiv:2507.13819](#)

Mass

$> 100 M_{\odot}$

$50-100 M_{\odot}$

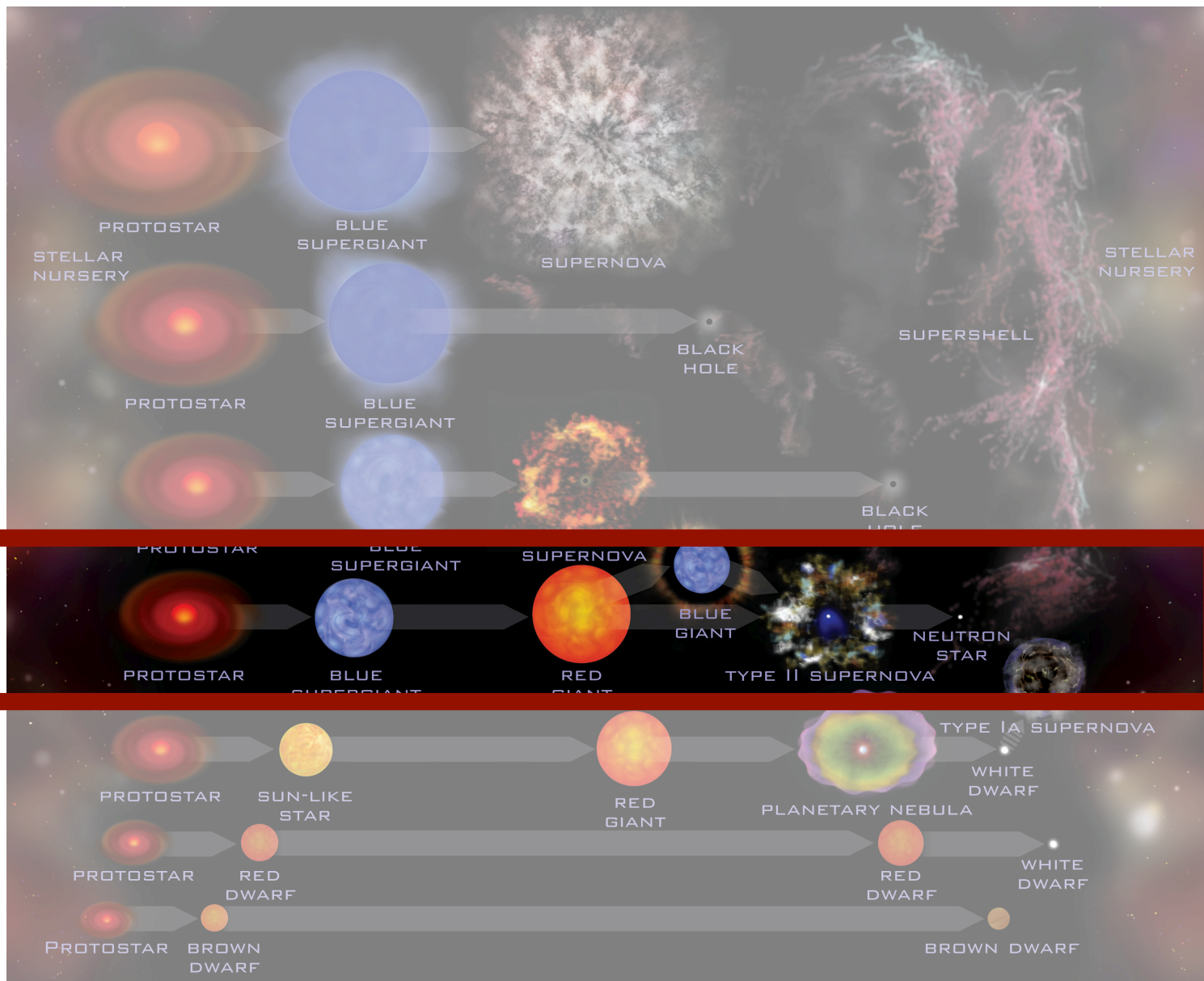
$25-50 M_{\odot}$

$8-25 M_{\odot}$

$0.4-8 M_{\odot}$

$0.08-0.4 M_{\odot}$

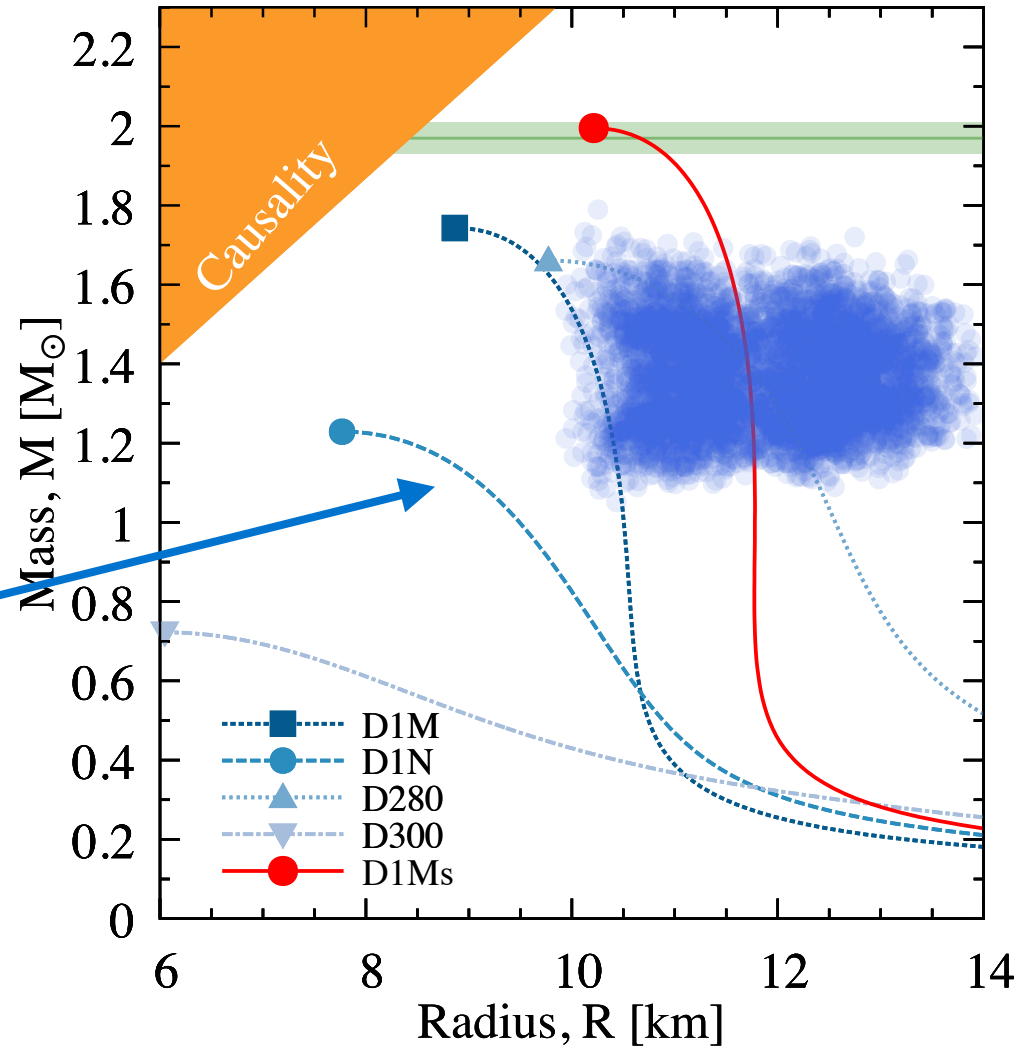
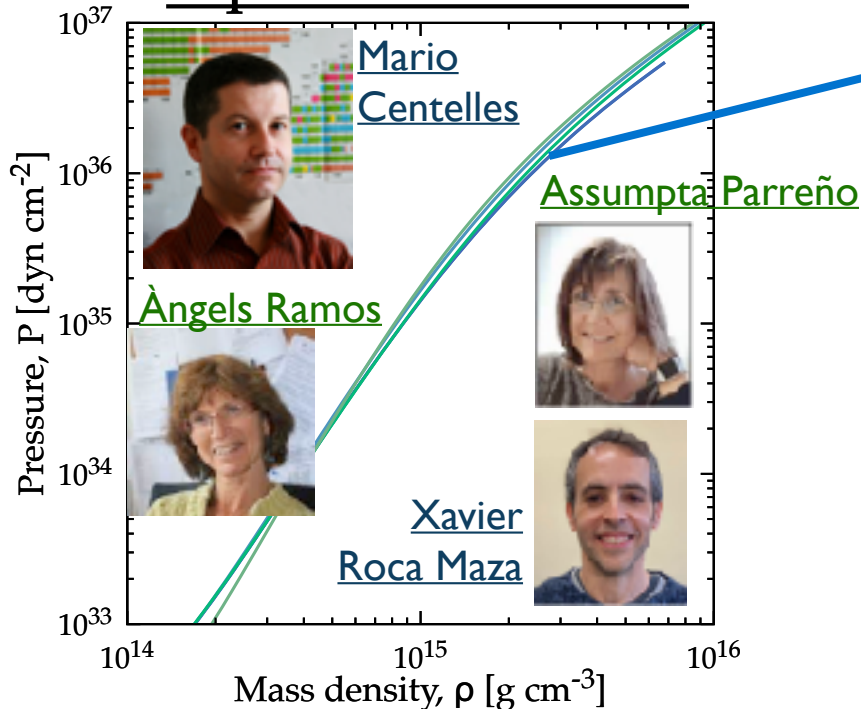
$< 0.08 M_{\odot}$



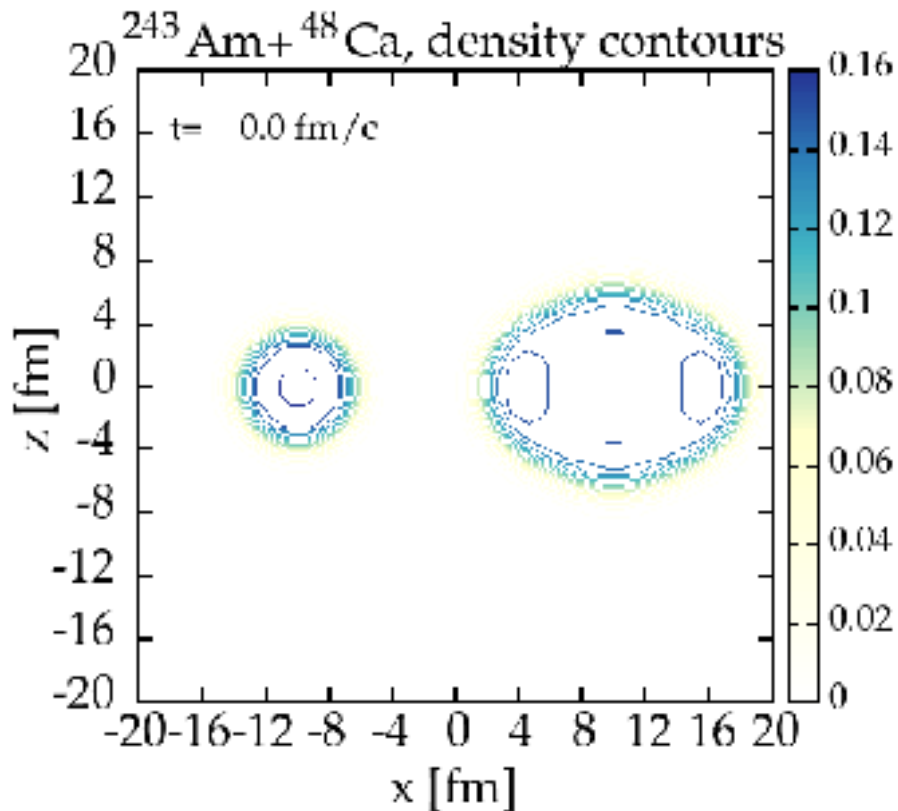
Gogny interaction

$$\begin{aligned}
 V(\vec{r}) = & \sum_{i=1,2} \left(W_i + B_i P_\sigma - H_i P_\tau - M_i P_\sigma P_\tau \right) e^{-\frac{r^2}{\mu_i}} \\
 & + \sum_{i=1,2} t_0^i (1 + x_0^i P_\sigma) \rho^{\alpha_i} \delta(\vec{r}) \\
 & + iW_0(\sigma_1 + \sigma_2)[\vec{k}' \times \delta(\vec{r})\vec{k}]
 \end{aligned}$$

Equation of State



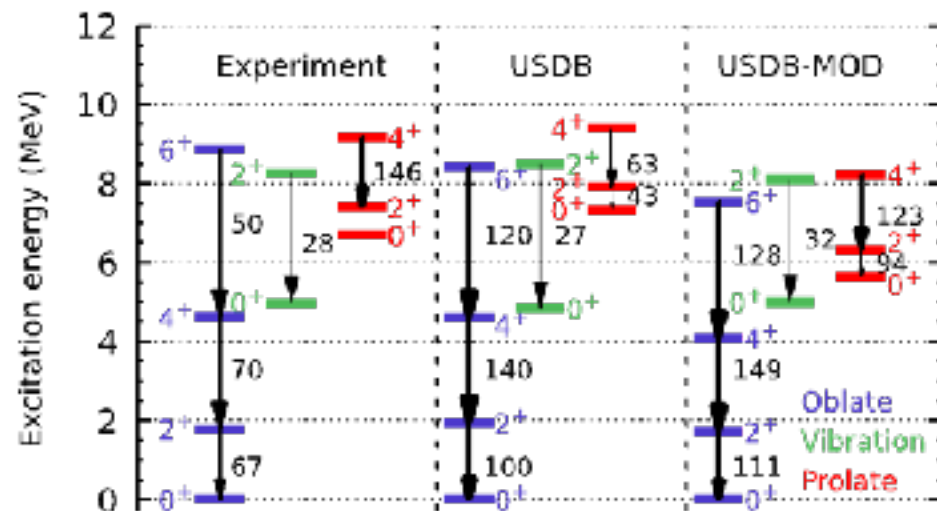
Can we create ^{291}Mc ?



TDHF simulations

Daniel Soler Miras@UB, FYP

What are the shapes of ^{28}Si ?



Shell model & HFB simulations

Dorian Frycz@UB, FYP+Master's

+ Isospin symmetry breaking
+ DFT simulations of nuclei
+ Functional development



Arnau Rios



Xavier Roca Maza



Javier Menéndez

PhD Funding Fellowships in Barcelona/Spain

	Funding agency	Deadline	Resolution	Phases
FI	 Agència de Gestió d'Ajuts Universitaris i de Recerca	End 2025	May 2026	1 phase
FPU	 MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES	Early 2026	June 2026	1 phase
INPHINIT	 Fundación "la Caixa"	Feb 2026	May 2026	2 phases
FI-SDUR / PREDOCS	 UNIVERSITAT DE BARCELONA	Mid 2026	Late 2026	1 phase
FPI	 AGENCIA ESTATAL DE INVESTIGACIÓN	Late 2026	Early 2027	Usually 2

Formalities

- Long response times
- Sign up to a PhD programme
- Non-trivial paperwork (especially for foreign students)



https://www.ub.edu/web/ub/en/estudis/suport_estudi/beques_ajuts/doctorat/beques_doctorat.html

<https://icc.ub.edu/education>; <http://secretaria.icc.ub.edu/student/grant>

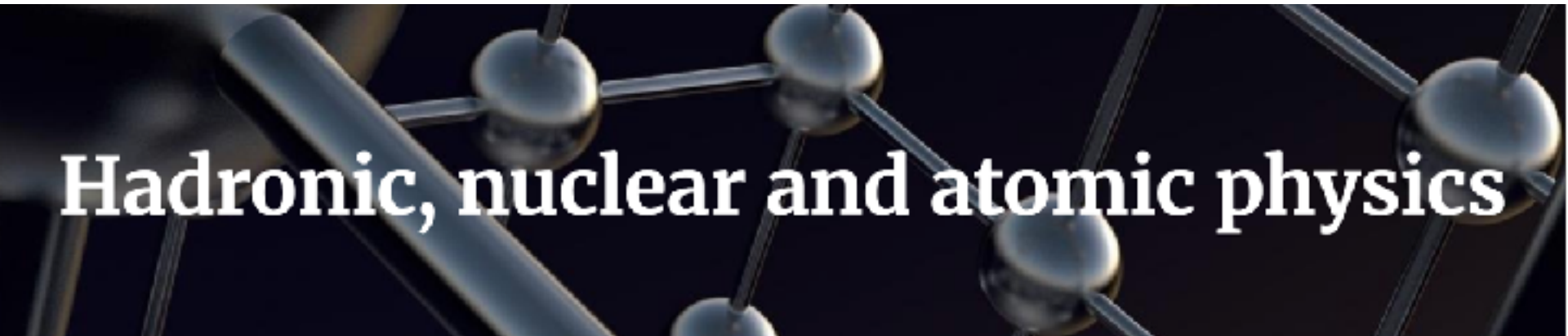
http://www.ub.edu/escola_doctorat/en/offerformative/doctoral-programmes-offered

PhD Fellowship (Pre-Selection) in Gravitational-wave physics

<https://icc.ub.edu/node/1292419>

PhD Fellowship (Pre-Selection Call) in Building interacting quantum systems one atom at a time

<https://icc.ub.edu/node/1292417>



Hadronic, nuclear and atomic physics

Contact us!

arnau.rios@icc.ub.edu

<https://sites.google.com/fqa.ub.edu/hadnucatub>

<https://icc.ub.edu/research/hadronic-nuclear-and-atomic-physics>