ICCUB | Institut de Ciències del Cosmos
UNIVERSITAT DE BARCELONA

EXCELENCIA MARÍA DE MAEZTU

UNIVERSITAT DE BARCELONA

@HadNucAtUB

Hadron & Nuclear Physics at UB

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

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



Sergi Gonzalez-Solis

Assistant Professor

Institute of Cosmos Sciences +

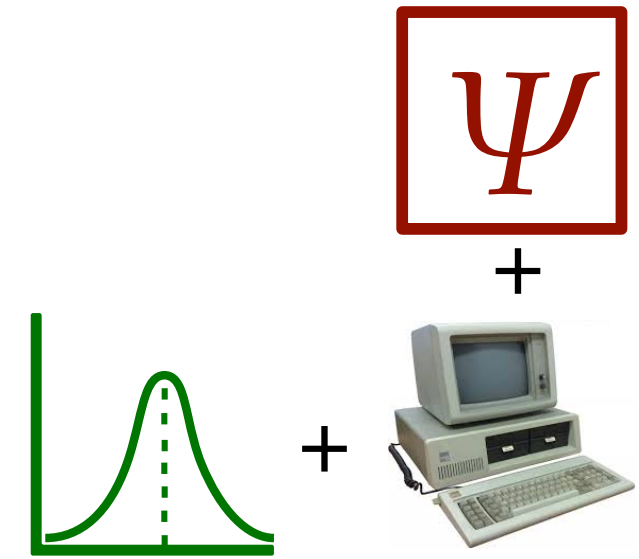
Universitat de Barcelona

sergig@icc.ub.edu

NucPhys Career Orientation Day

16 November 2026

What do we do?







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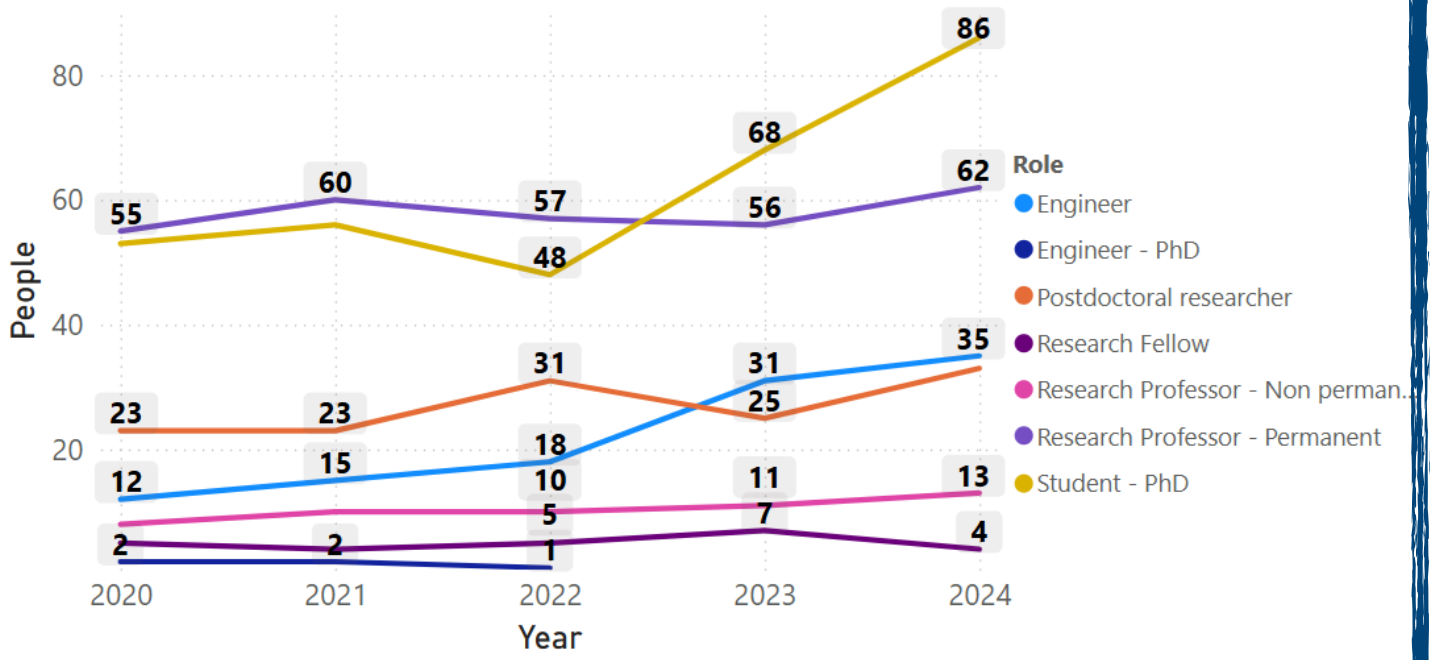


- **Theoretical** and **computational** research
- ICCUB group, access to **mentorship** schemes
- Longstanding **PhD supervision experience**
- Science outreach

Who are we?



Àngels Ramos
Full Professor



Assumpta Parreño
Full Professor



Volodya Magas
Associate Professor



Vincent Mathieu
Associate Professor

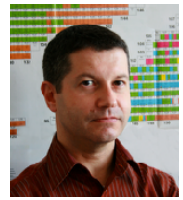


Juan Torres-Rincón
Associate Professor



Sergi González-Solís
Assistant Professor

Mario Centelles
Associate Professor



Javier Menéndez
Associate Professor



Arnau Rios
Associate Professor



Xavier Roca Maza
Beatriz-Galindo Researcher



Post-doctoral researchers

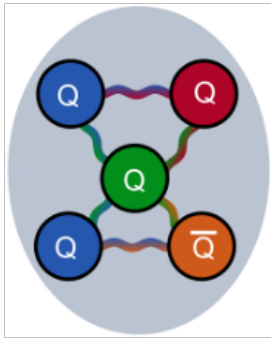
- Glòria Montaña
- Emilio J. Estrada
- Hristian Kochankovski
- Chiranjib Mondal

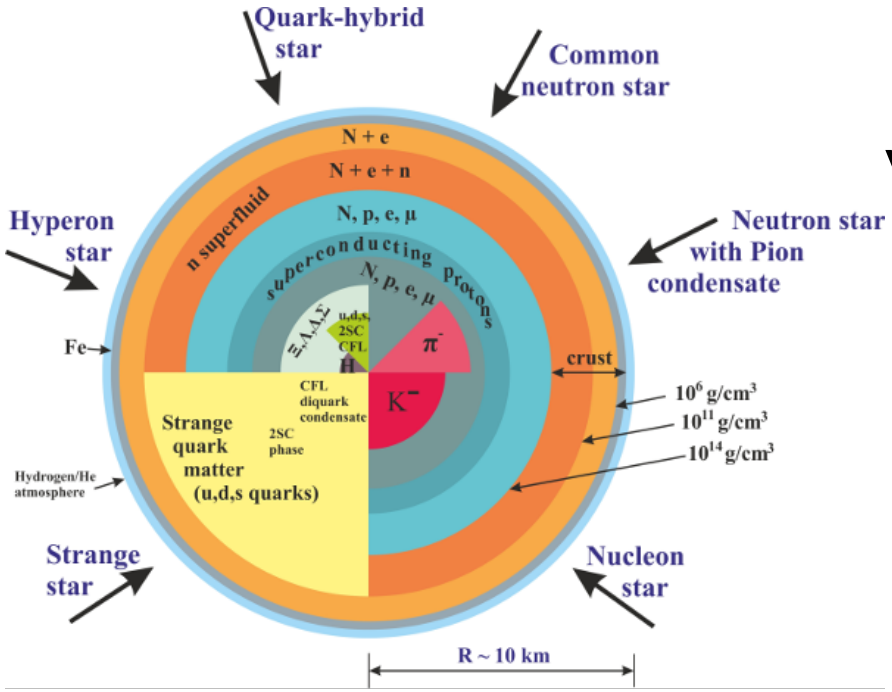
Pre-doc researchers

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

Fundamental questions in hadron physics

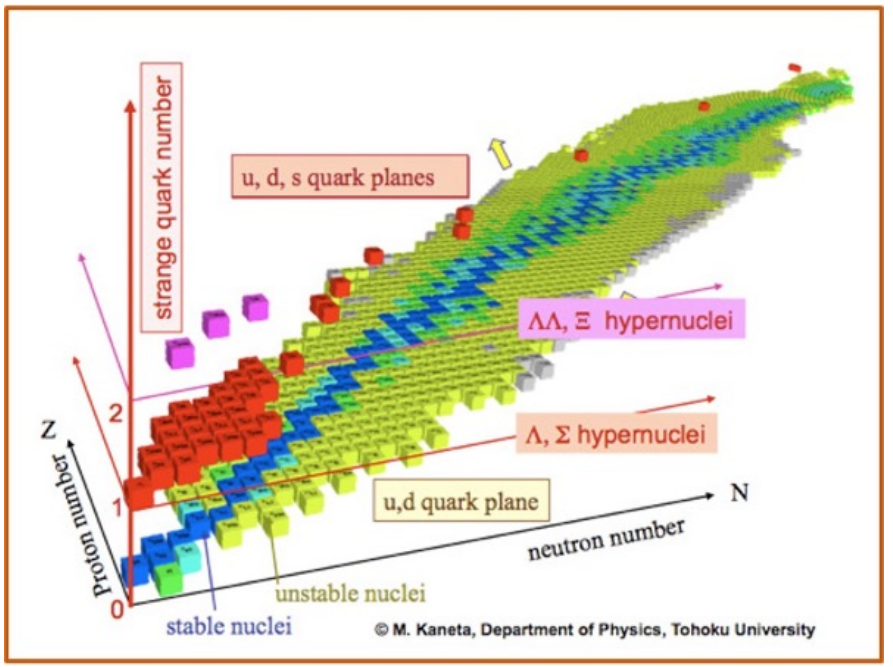
What are the properties of exotic states?



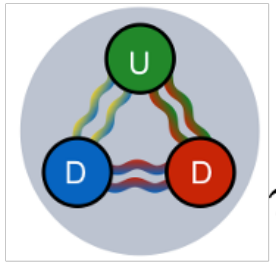


What role does strangeness play in neutron stars?

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

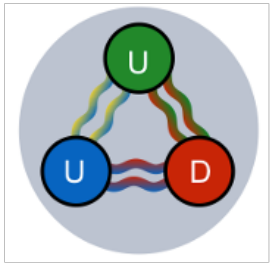


Ordinary and exotic hadrons



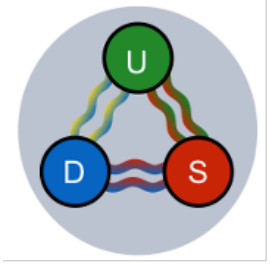
neutron

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



proton

stable

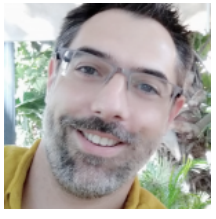


baryon Λ

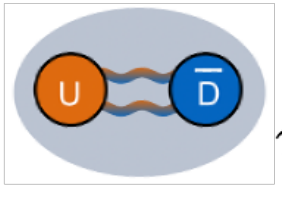
$\tau \sim 10^{-10} s$



Vincent Mathieu

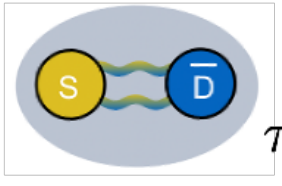


Ordinary mesons



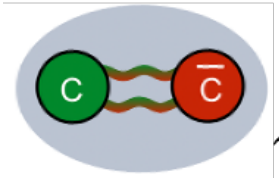
pion π

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



kaon

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



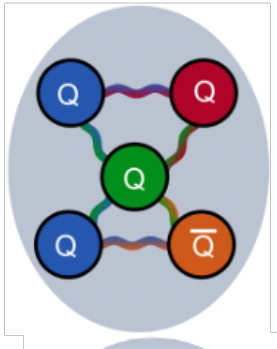
J/ψ

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

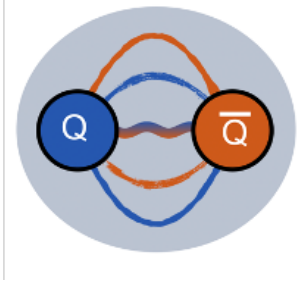
Exotic matter



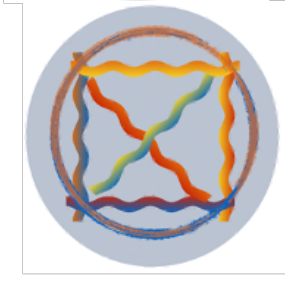
tetraquarks



pentaquarks

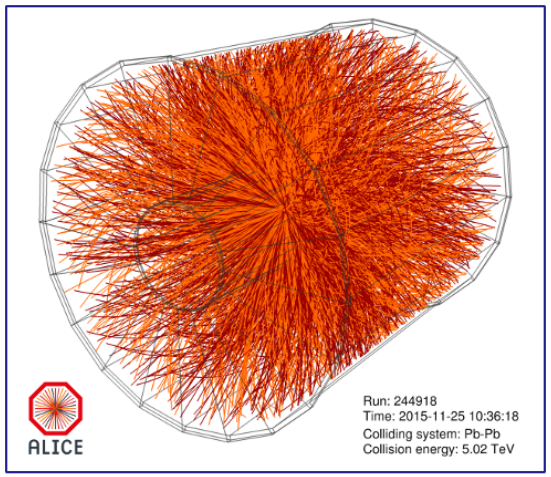


hybrid mesons

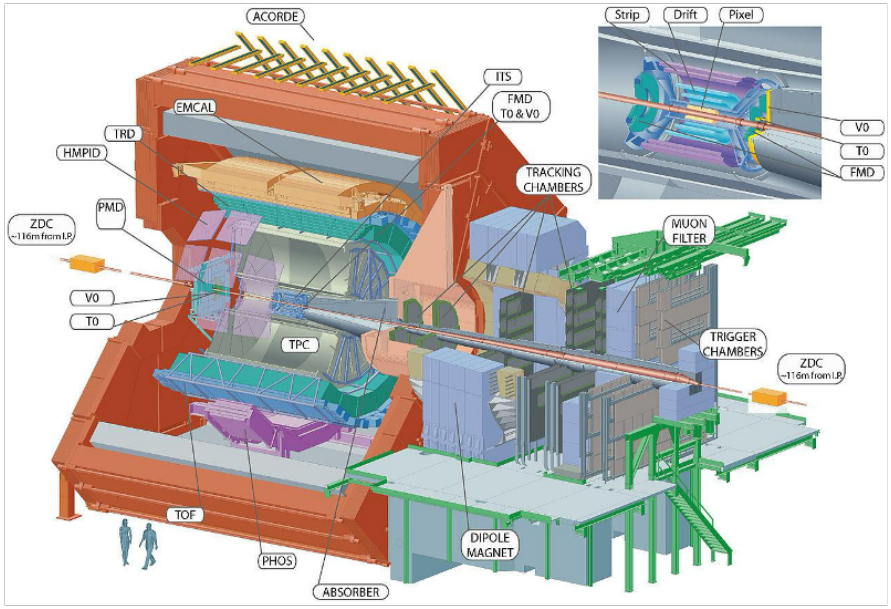


glueballs

Heavy ion collisions

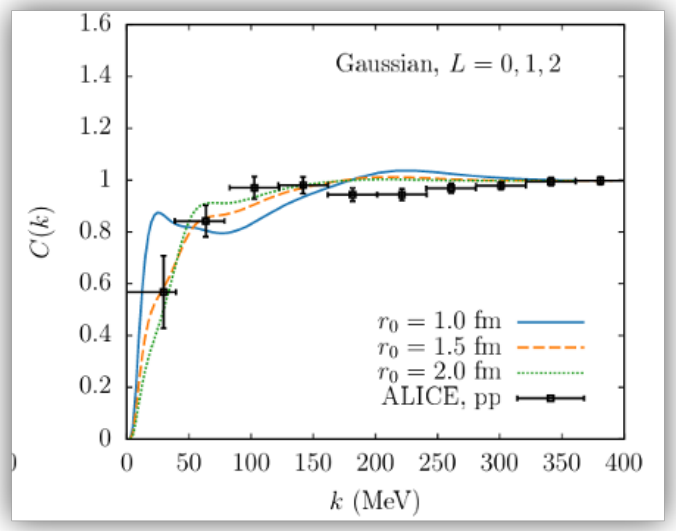


PbPb @
$\sqrt{s_{NN}} = 5.02$ TeV

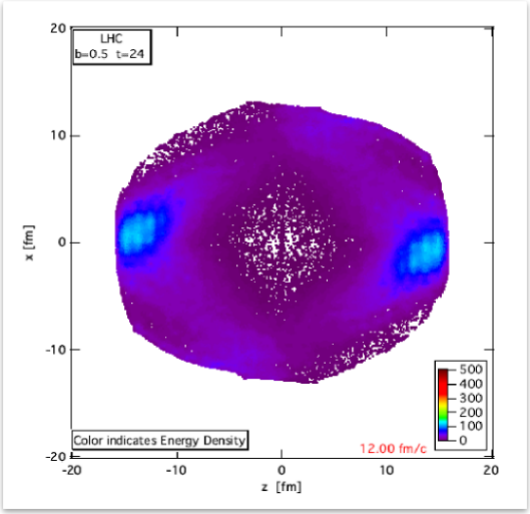


Experiment ALICE @ LHC (CERN)

Femptoscopy studies



Hydro simulations



Volodya Magas



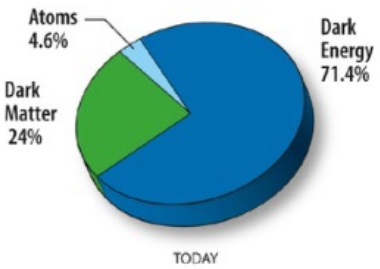
Juan Torres-Rincón



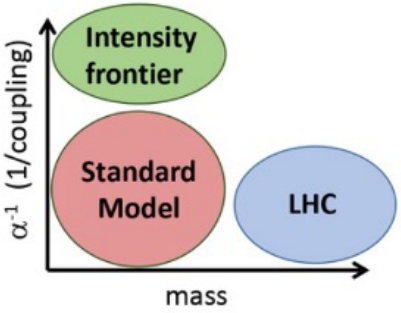
New Physics Searches

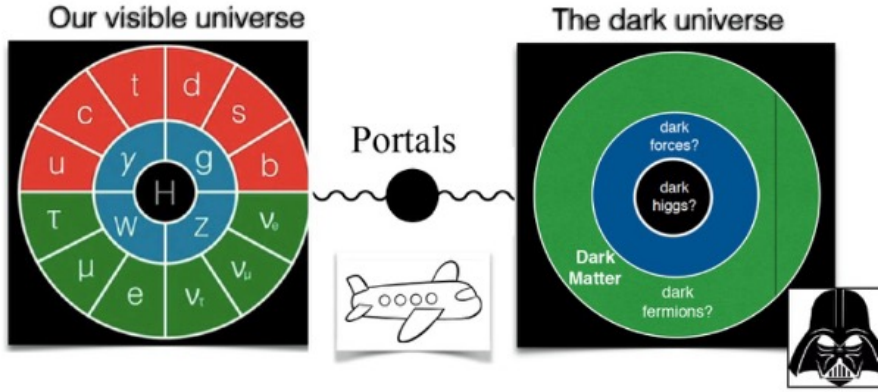
Searching for **New Physics** in Hadronic processes

Evidence of New Physics!

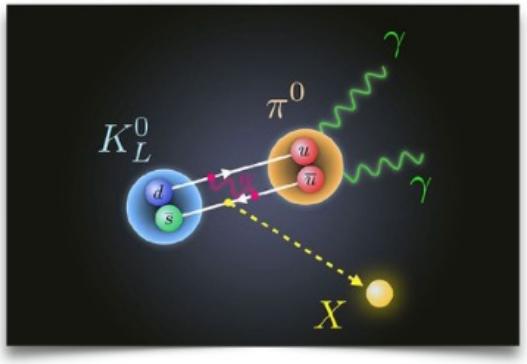


Where is the New Physics?

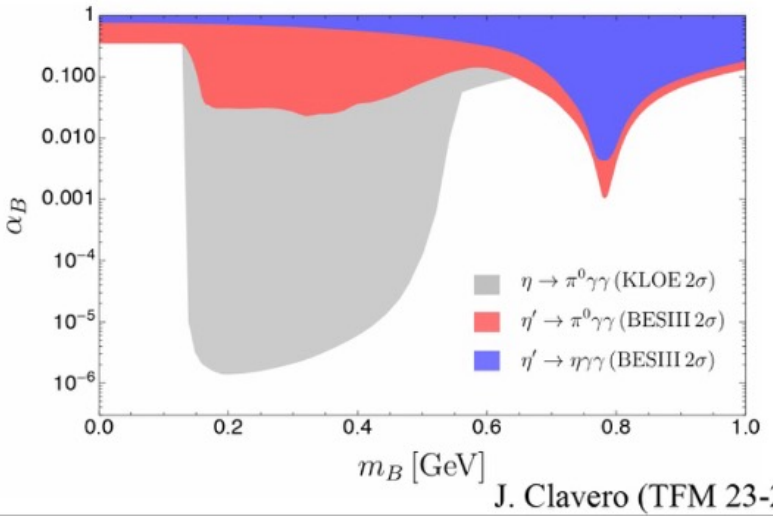




Imprints in rare meson decays: requires **Hadronic Physics** accurately predicted!



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

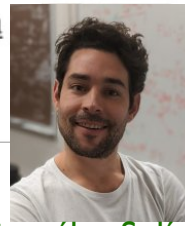


J. Clavero (TFM 23-24)

Worldwide experiments

Belle II CMS BESIII REDTOP

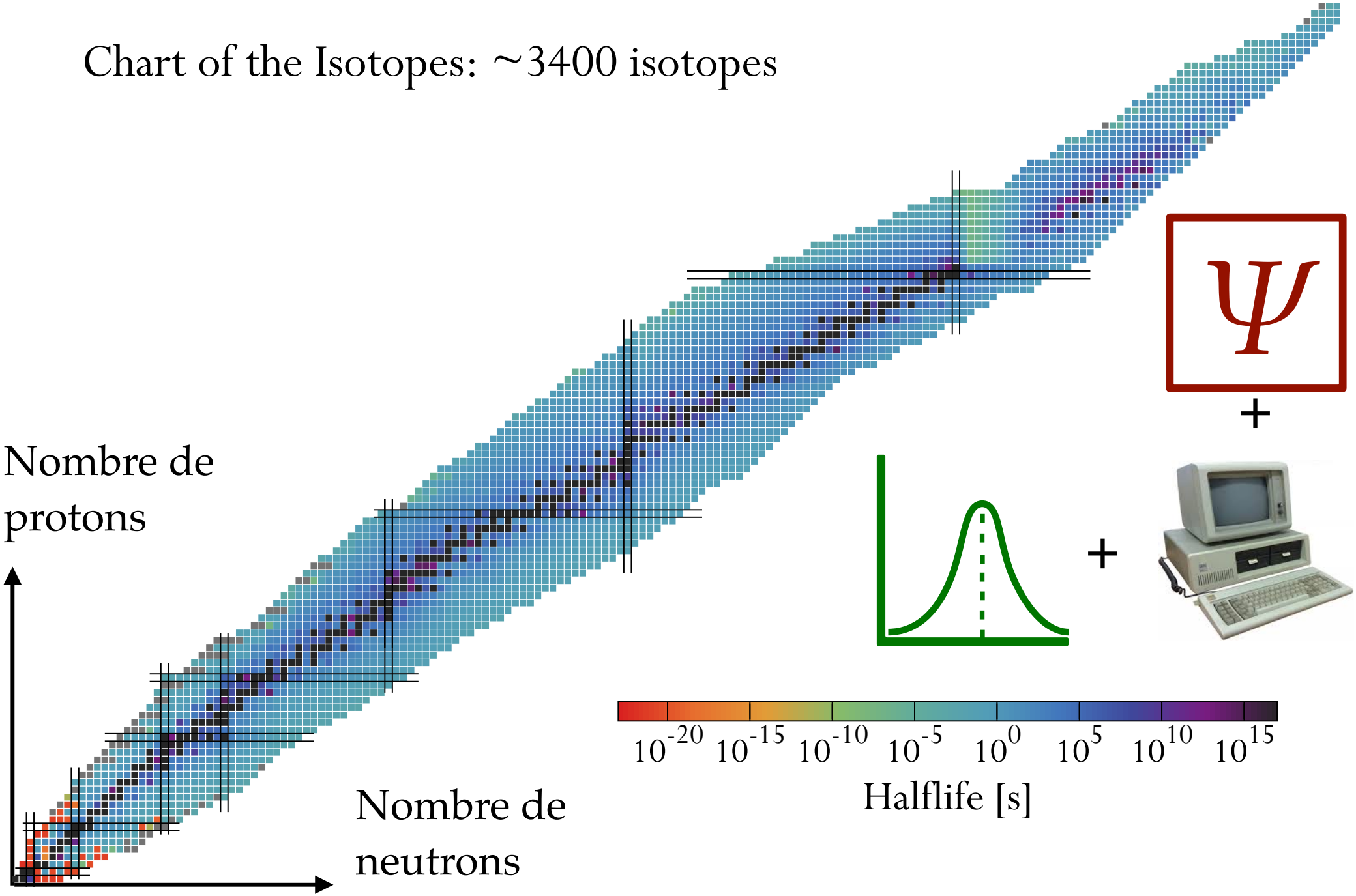
sergig@fqa.ub.edu



Sergi González-Solís

Segrè chart and theory

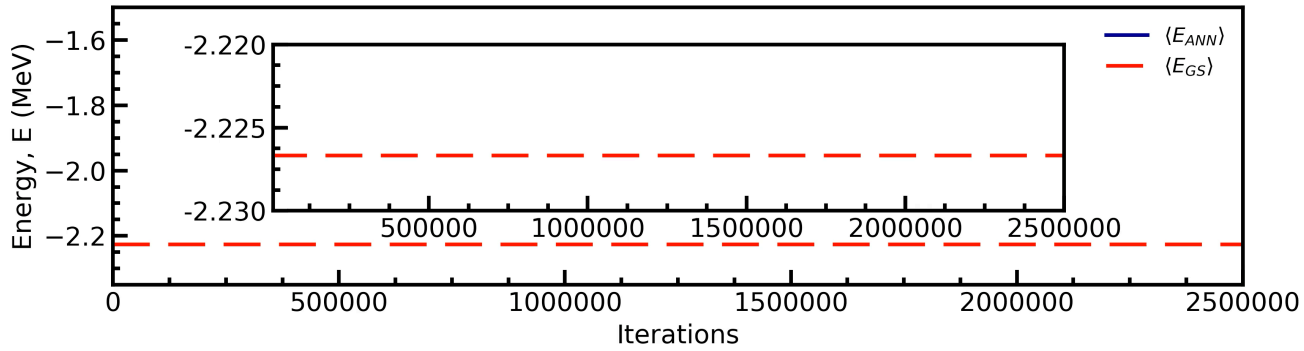
Chart of the Isotopes: ~3400 isotopes



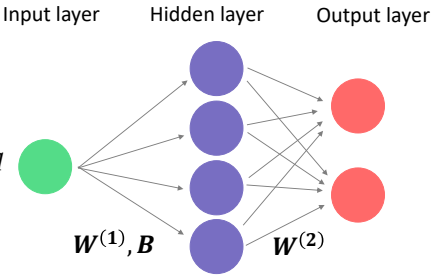
AI & quantum computing nuclei

Neural Quantum States

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

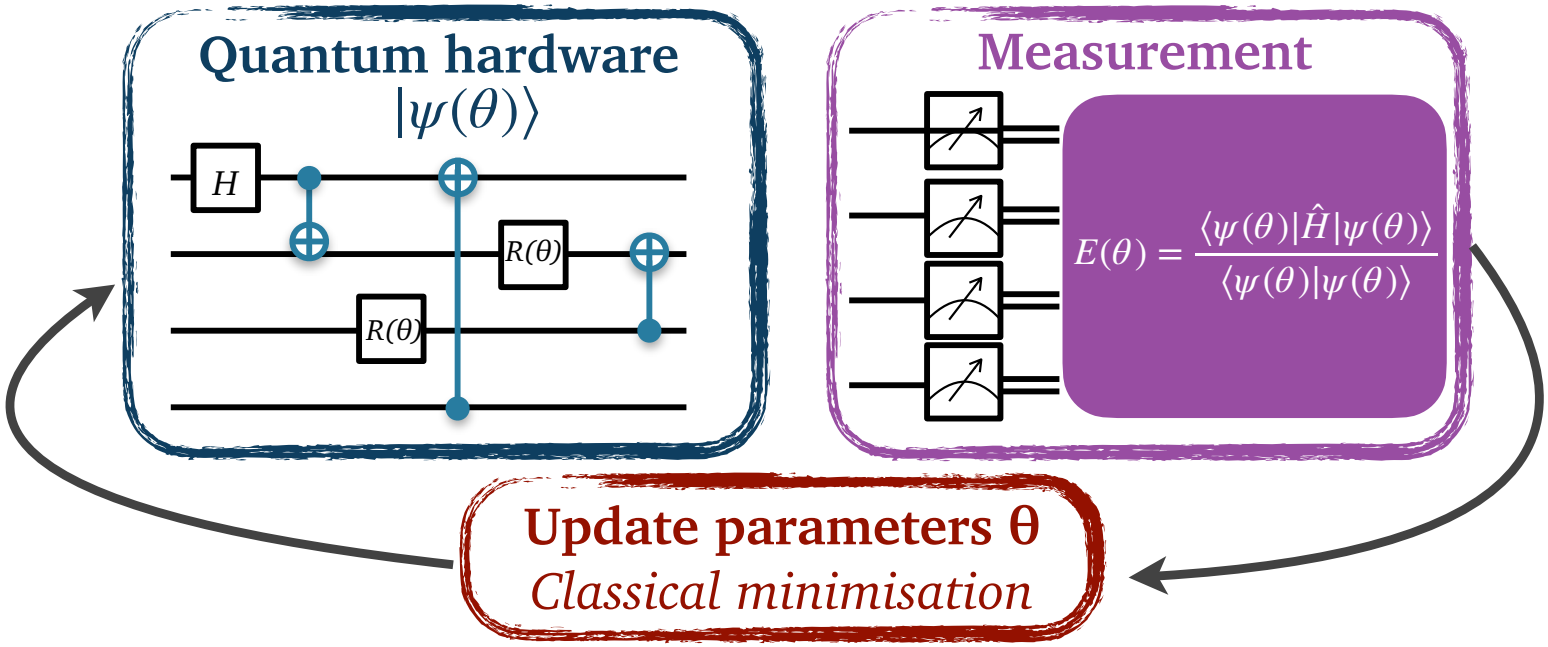


$$|\psi_\theta\rangle =$$

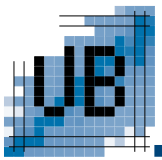
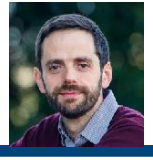


Keeble & Rios, Phys. Lett. B **809** 135743 (2020); J.W.T. Keeble, PhD Thesis; Keeble et al, Phys. Rev. A **108**, 063320 (2023)

Variational Quantum Eigensolver

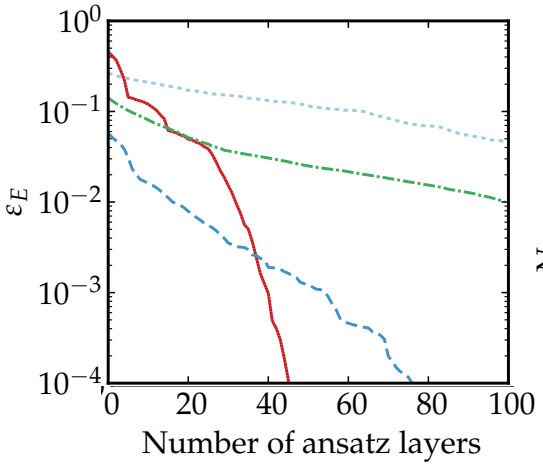


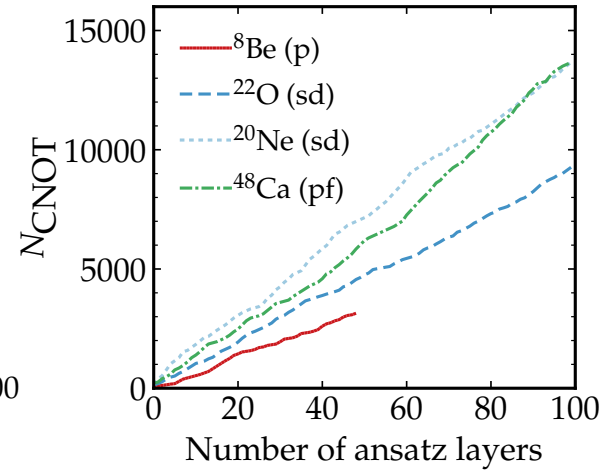
Pérez-Obiol *et al.* Scientific Reports **13**, 12291 (2023); EPJA **59**, 240 (2023)


Results

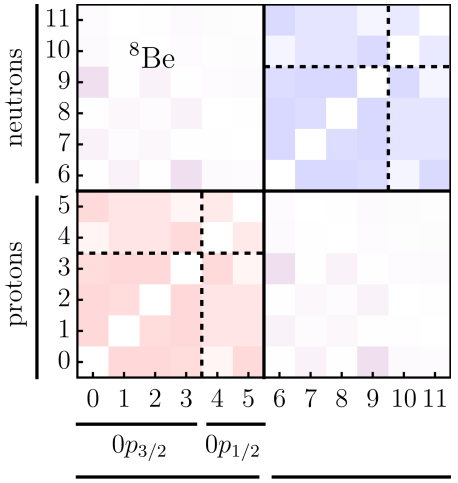
Resources





Pérez-Obiol, Romero et al Scientific Reports **13**, 12291 (2023)

Entanglement

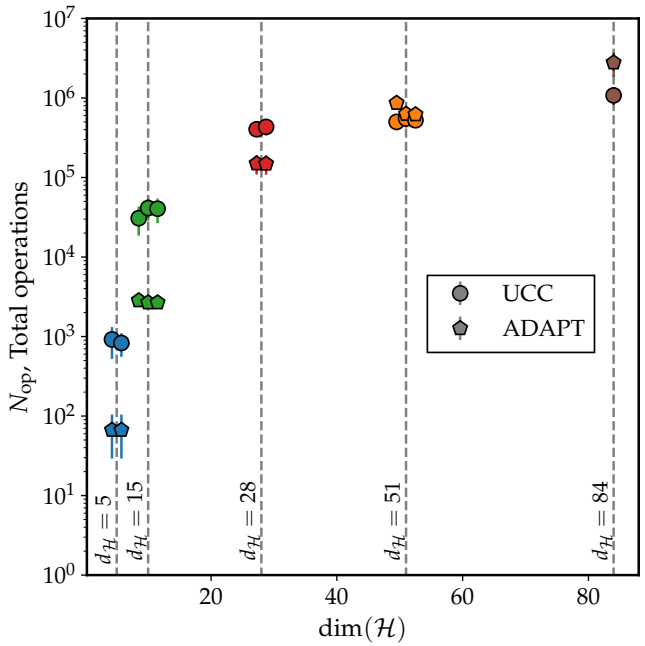


A. Pérez-Obiol, et al. EPJA 59, 240 (2023)

MareNostrum Ona @BSC

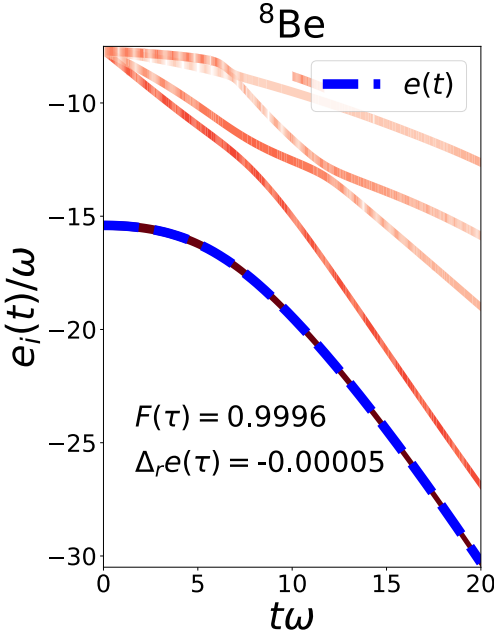


VQE comparisons



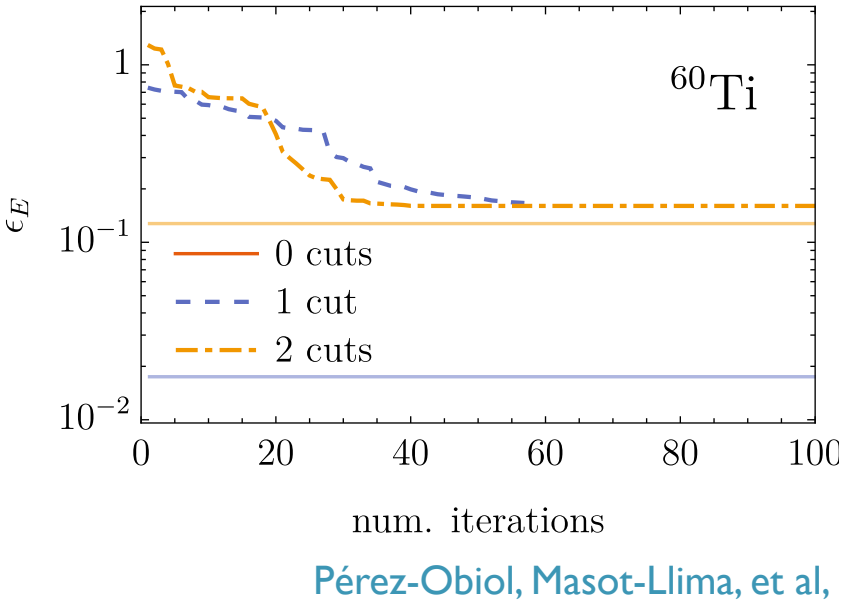
10Carrasco-Codina *et al.*, arXiv:2507.13819

Adiabatic



Costa et al., arXiv:2411.06954

Entanglement forging



Pérez-Obiol, Masot-Llima, et al, arXiv:2409.04510

Death of stars

Mass

$>100\ M_\odot$

$50\text{-}100\ M_\odot$

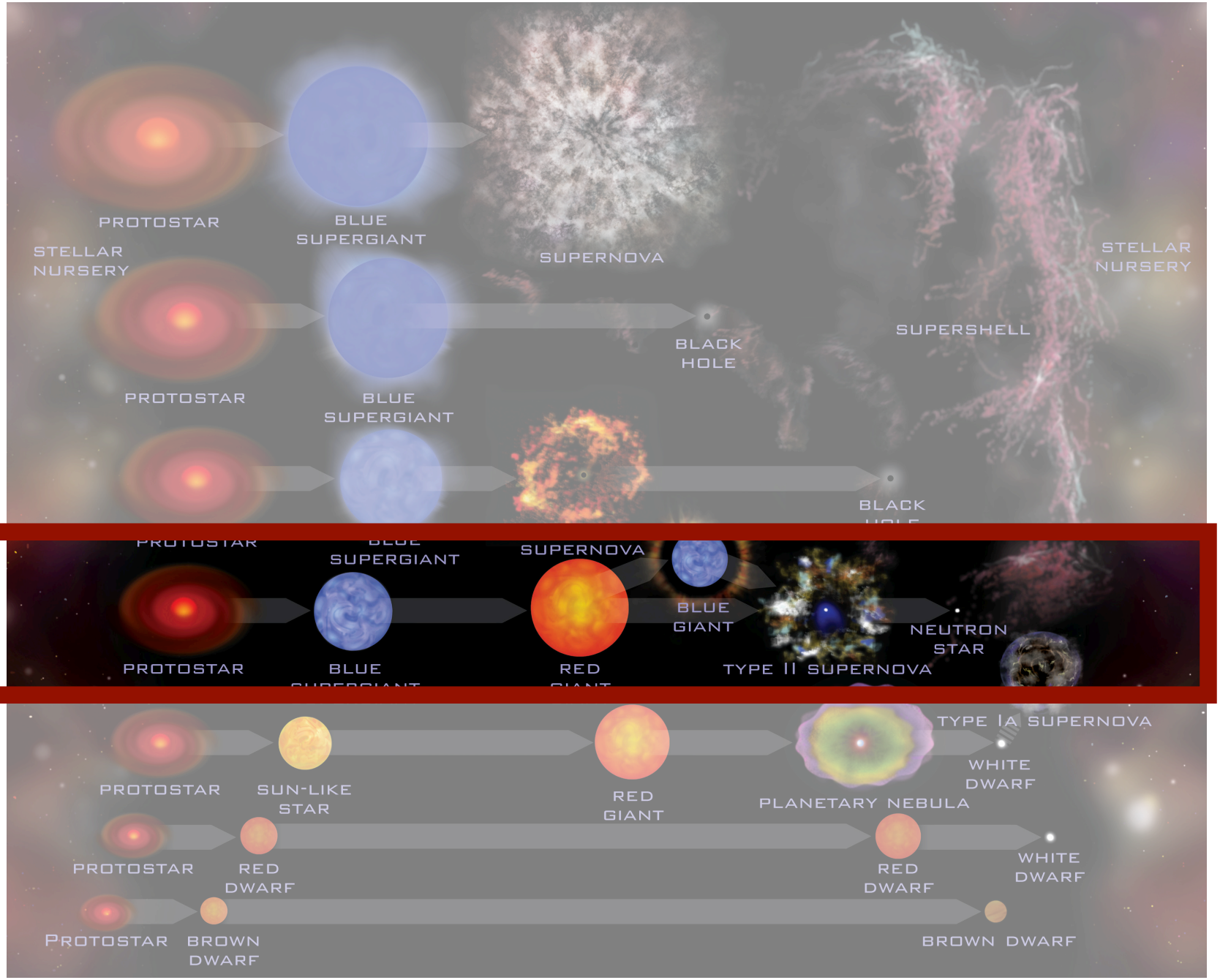
$25\text{-}50\ M_\odot$

$8\text{-}25\ M_\odot$

$0.4\text{-}8\ M_\odot$

$0.08\text{-}0.4\ M_\odot$

$<0.08\ M_\odot$



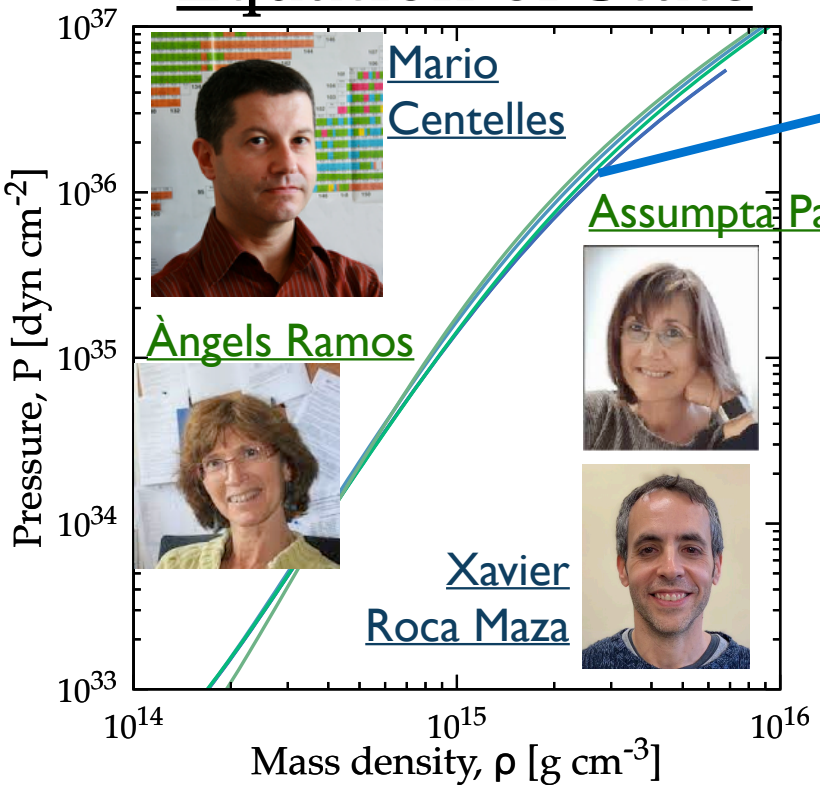
http://chandra.harvard.edu/resources/flash/stellar_evolution.html

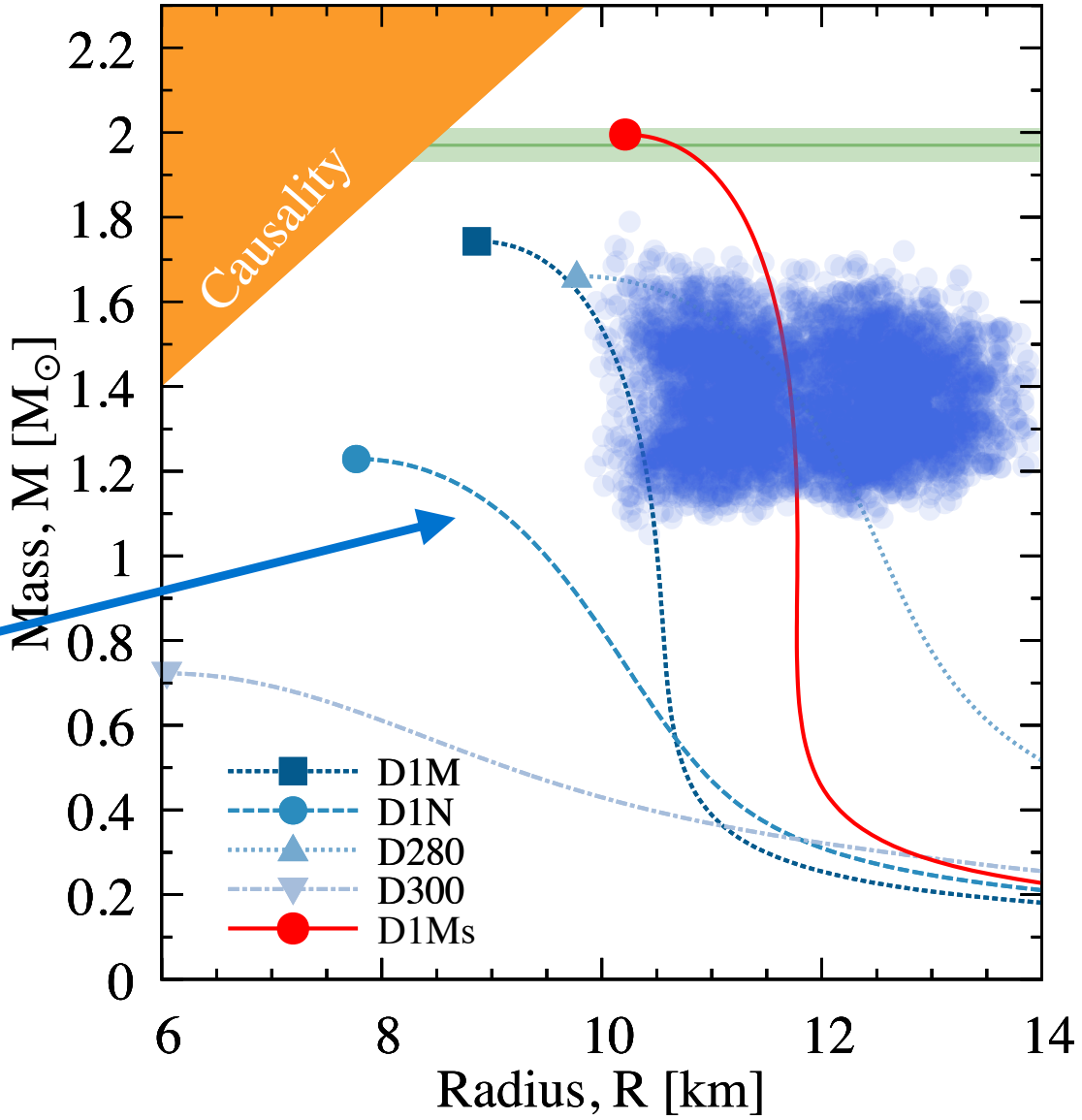
Neutron stars

Gogny interaction

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

Equation of State

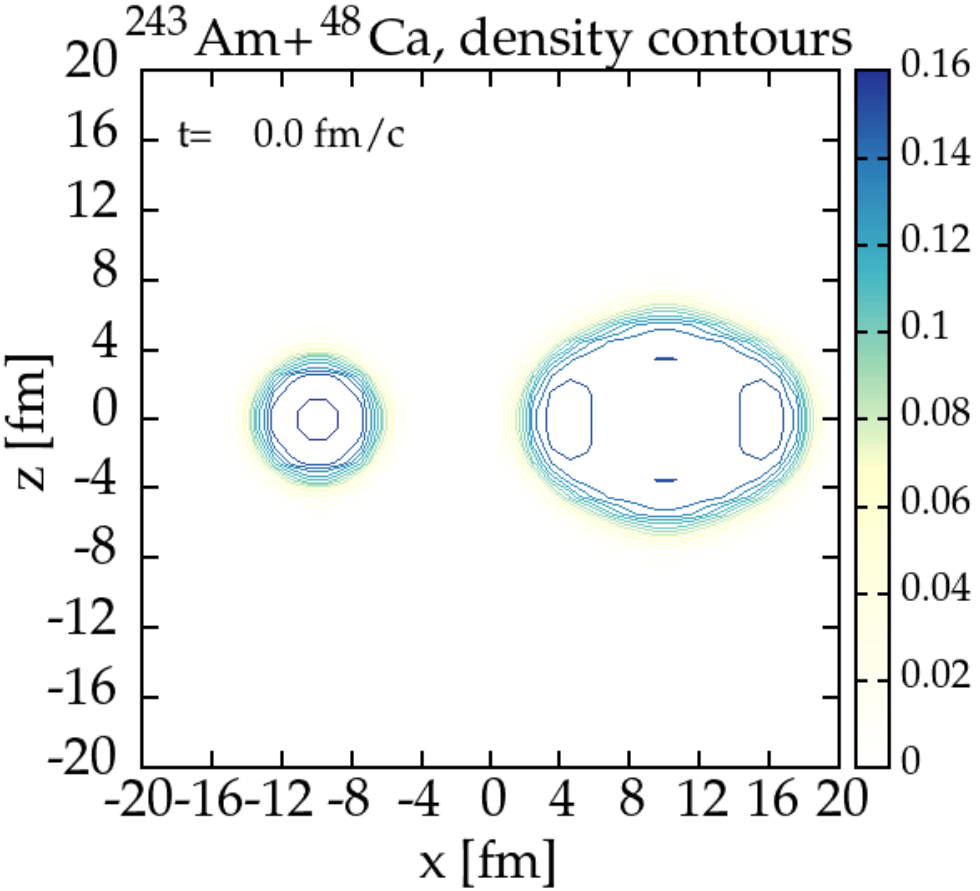




PhD thesis Claudia Gonzalez Borquera
http://hdl.handle.net/2445/151941

Nuclear structure & dynamics

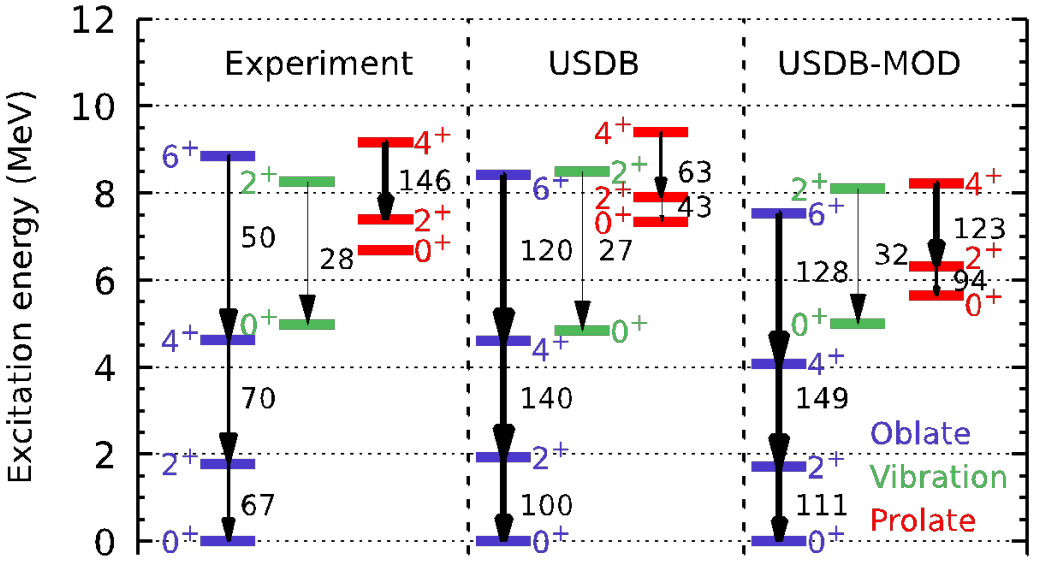
Can we create ^{291}Mc?



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

PhDs in Spain

PhD Funding Fellowships in Barcelona/Spain				
	Funding agency	Deadline	Resolution	Phases
FI	AGAUR Agència de Gestió d'Ajuts Universitaris i de Recerca	Early 2027	May 2027	1 phase
FPU	MINISTERIO DE CIENCIA, INNOVACIÓN Y UNIVERSIDADES	Nov 2026	June 2027	1 phase
INPHINIT	Fundación "la Caixa"	Feb 2027	May 2027	2 phases
FI-SDUR / PREDOCS	UNIVERSITAT DE BARCELONA	Mid 2027	Late 2027	1 phase
FPI	AGENCIA ESTATAL DE INVESTIGACIÓN	Late 2027	Early 2028	Usually 2

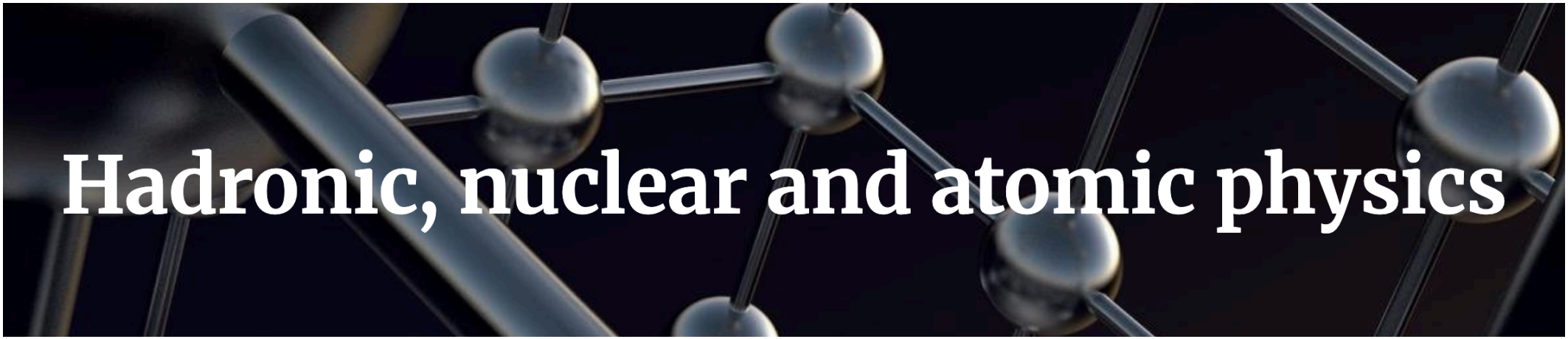
Formalities



- **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

If you are interested…



Contact us!

sergig@icc.ub.edu

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

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

UNIVERSITAT DE BARCELONA

Departament de Física Quàntica i Astrofísica

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