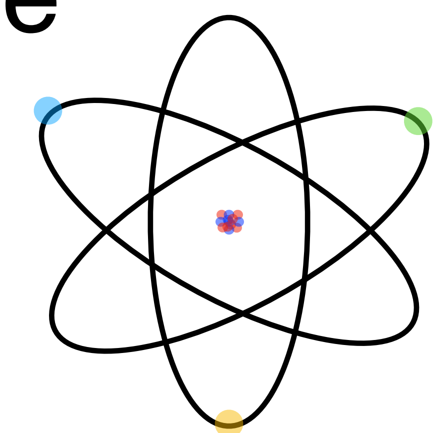
Exploring fundamental science at the intersection of atomic and nuclear physics

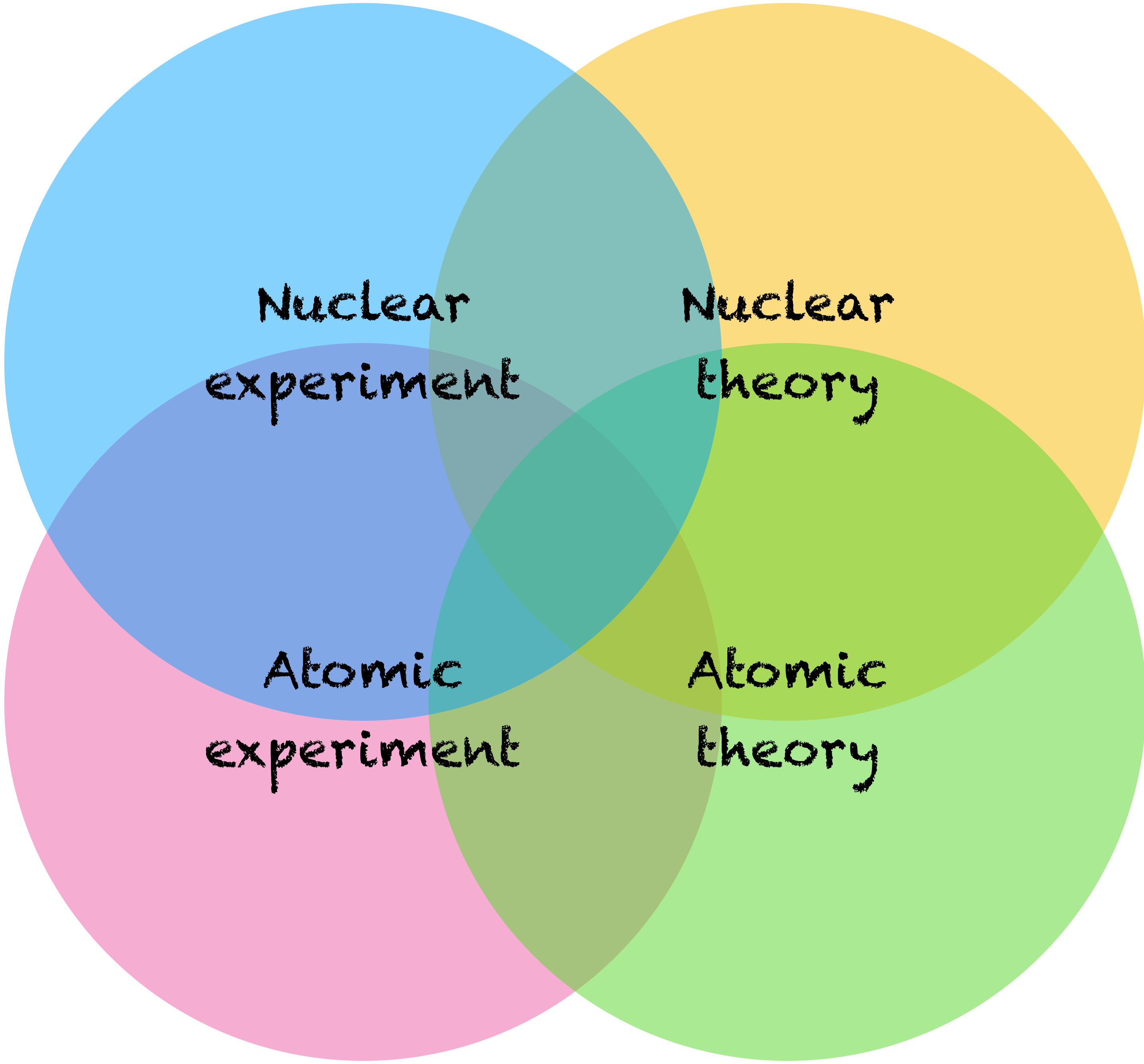


Jacinda Ginges

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

Australian Government
Australian Research Council

Synergies/collaborations



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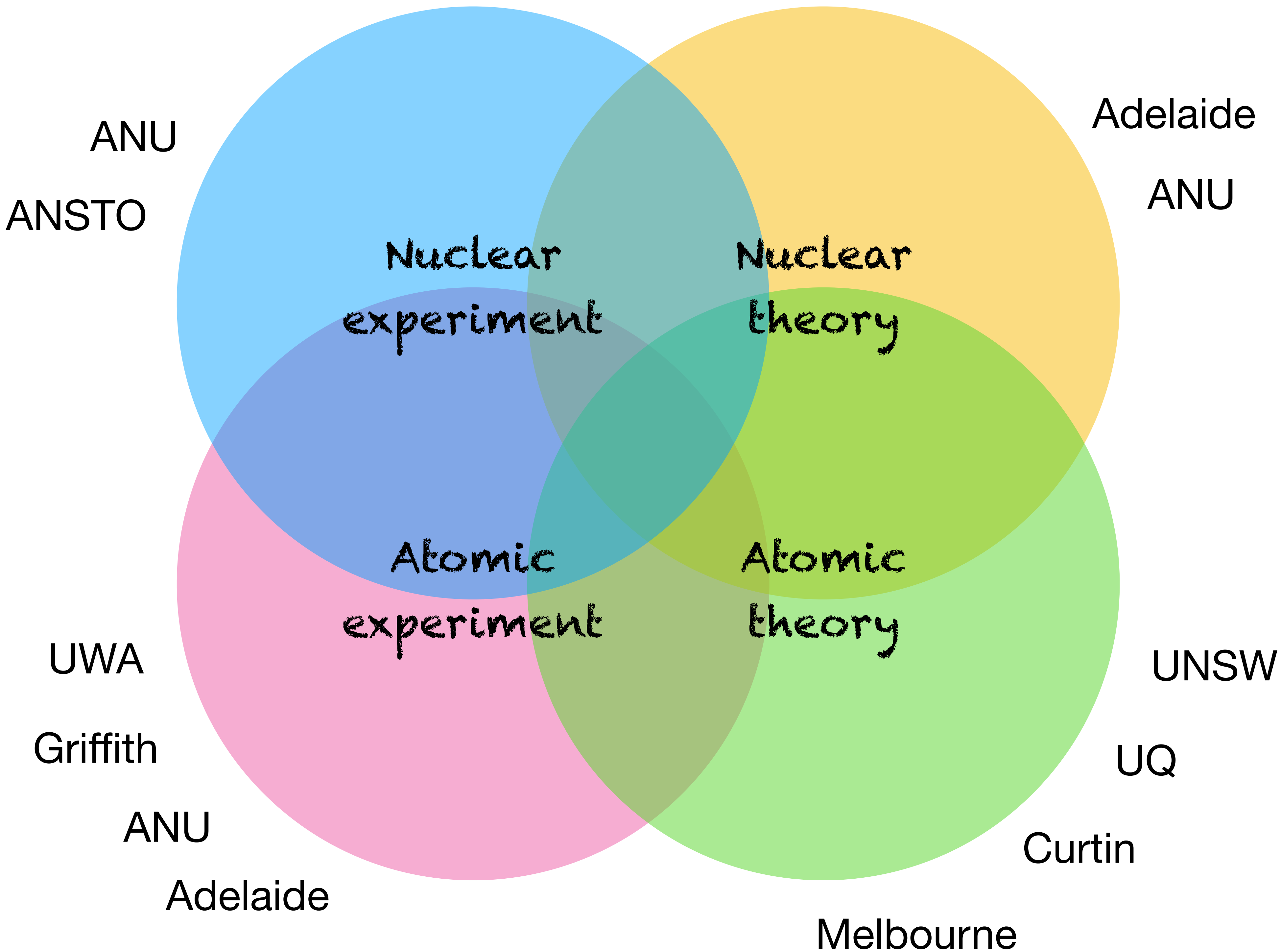
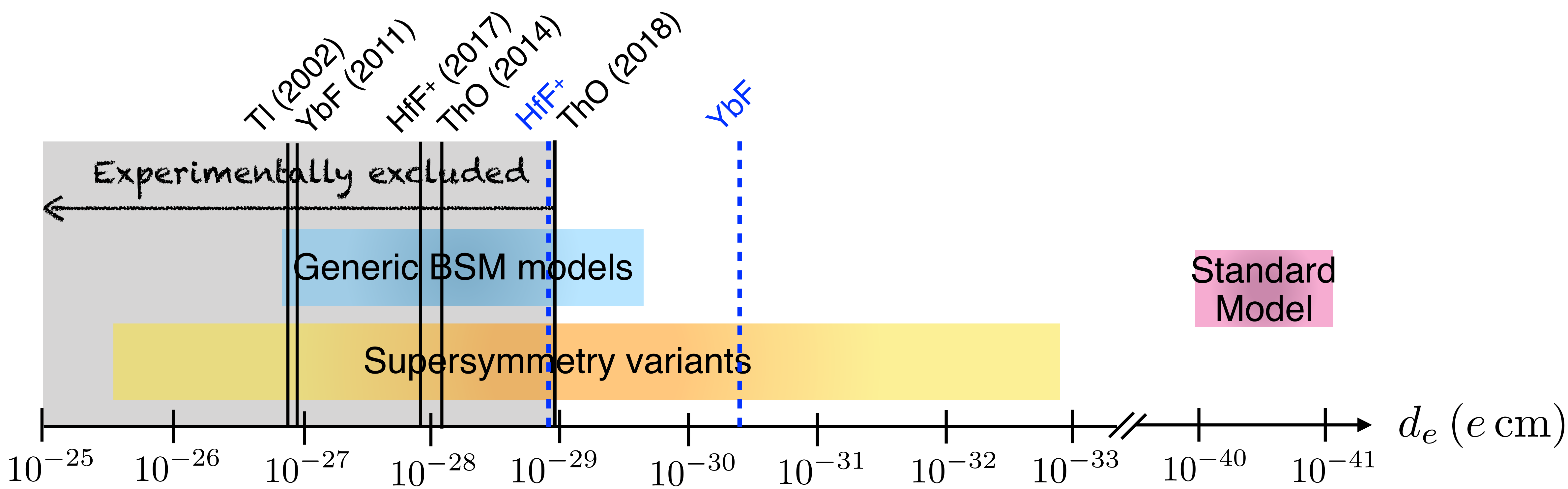
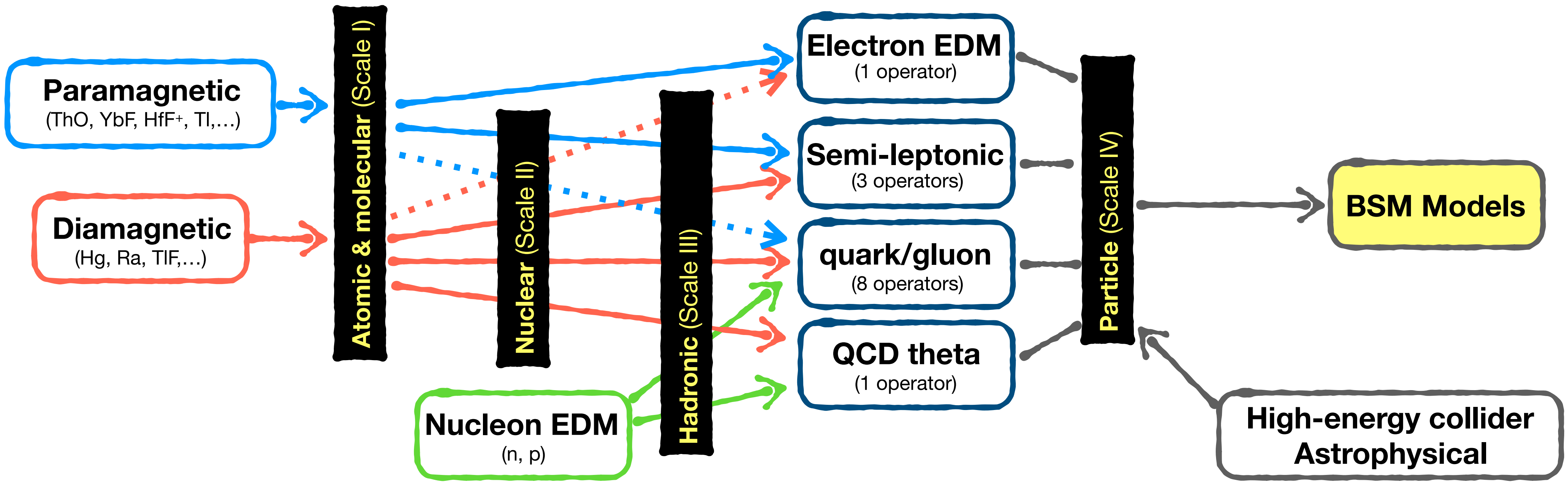


Electric dipole moments

- Search for CP-violation beyond standard model
- Could shed light on matter-antimatter asymmetry of Universe
- Next big particle physics discovery?



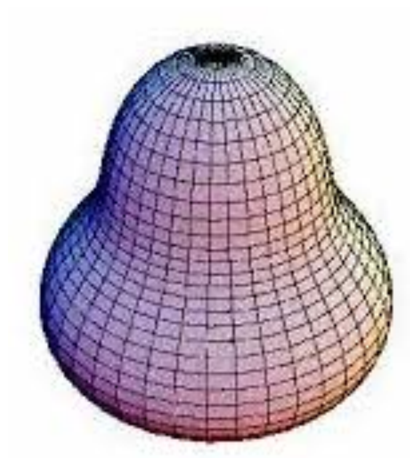
from EDM DP application: J. Zanotti, M. White, J. Ginges, C. Simenel, R. Young



➤ Cross-disciplinary theory, spanning atomic and molecular → nuclear → hadronic → particle

➤ Parity- and time-reversal-violating nuclear moments, e.g., Schiff, magnetic quadrupole, electric octupole

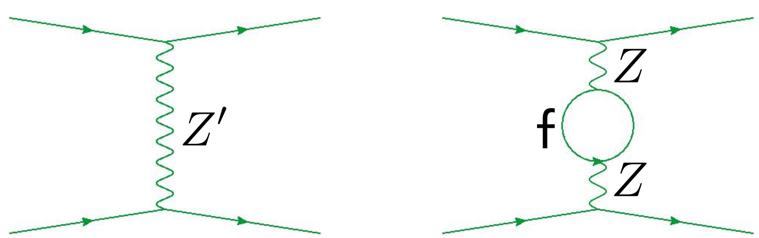
➤ Nuclear octupole deformation

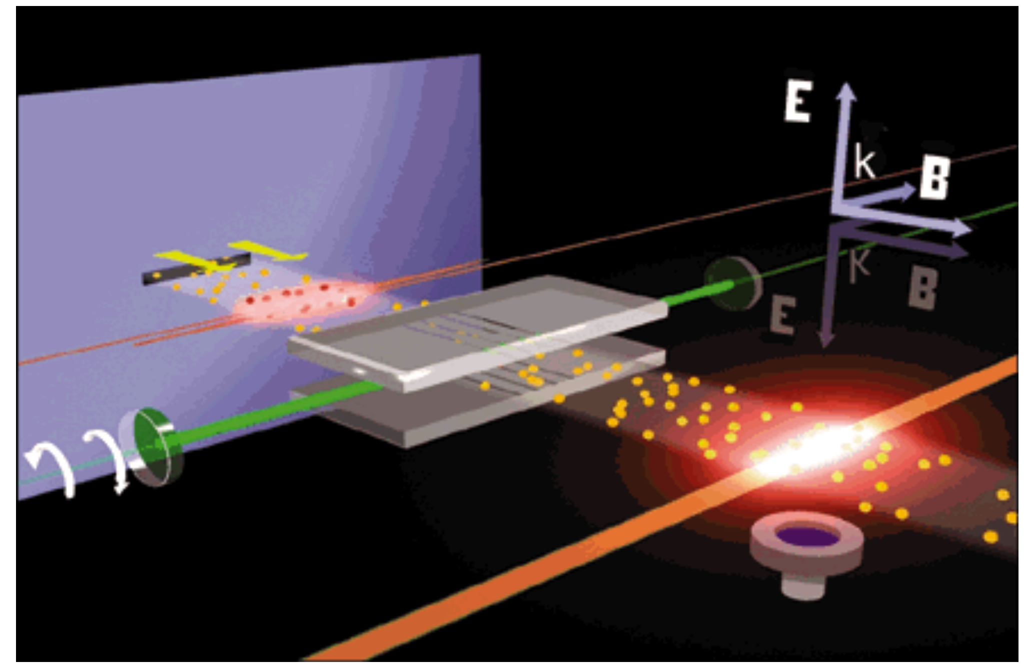


Atomic parity violation

<u>Nuclear weak charge</u>

➤ test of standard model and search for new physics





Nuclear uncertainties that limit theory interpretation

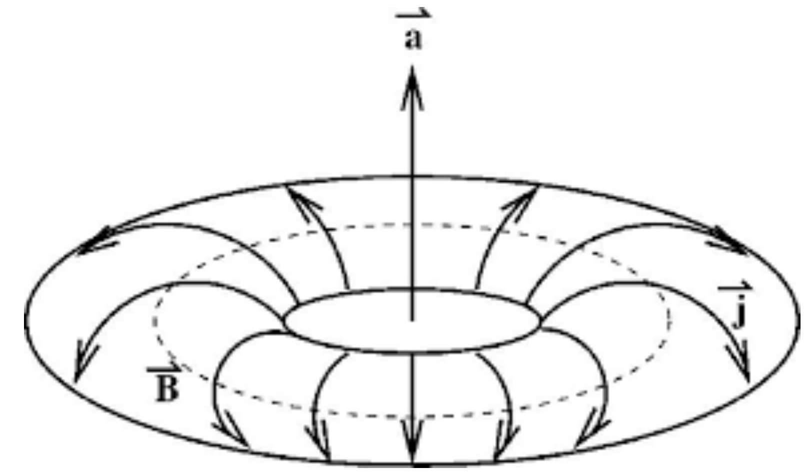
➤ neutron skin R_n-R_p

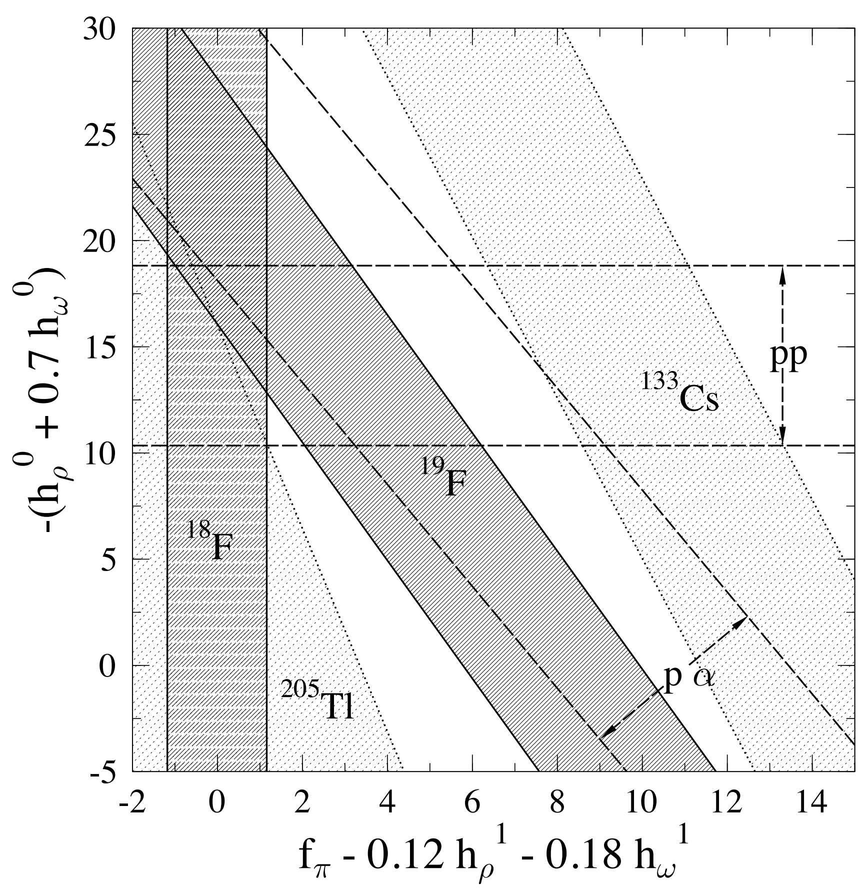
➤ nuclear magnetisation distribution

➤ nuclear charge distribution (?)

Nuclear anapole moment

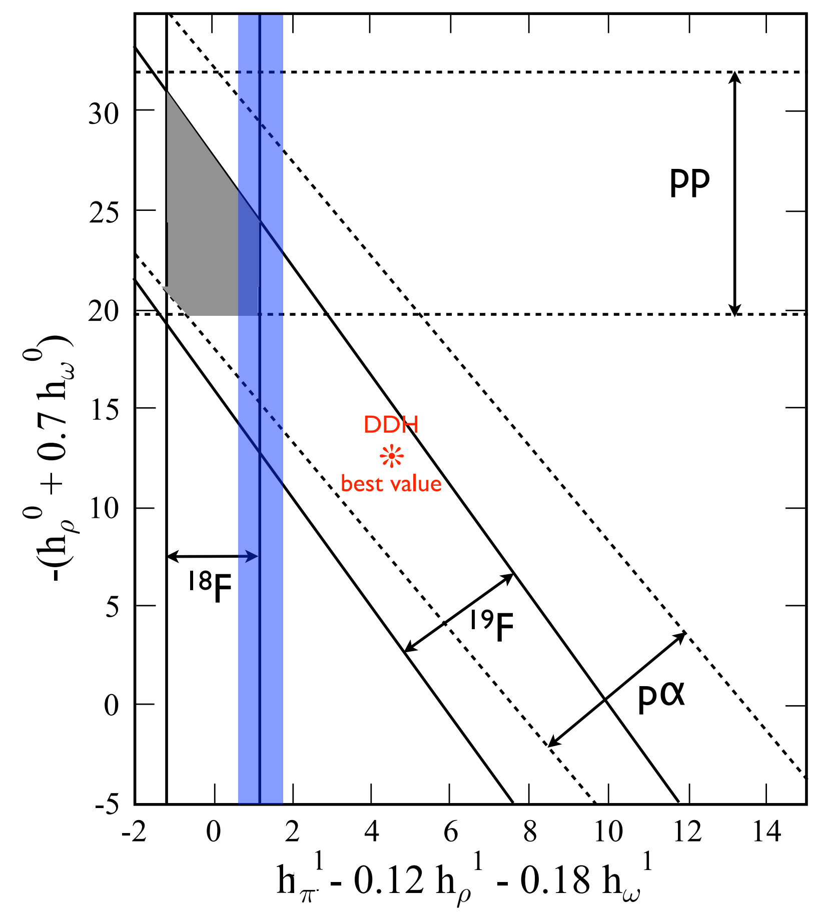
- ➤ probe of hadronic parity violation
- ➤ cesium result in tension with other experiments





Haxton and Wieman (2001)

vs



(Blue: lattice QCD)

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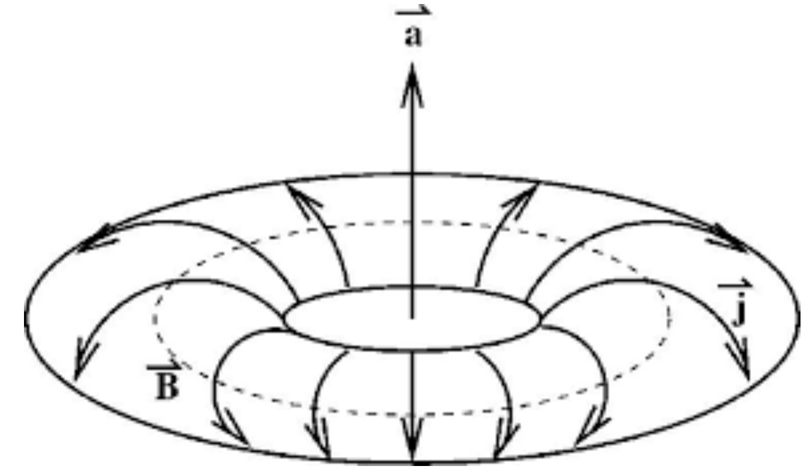

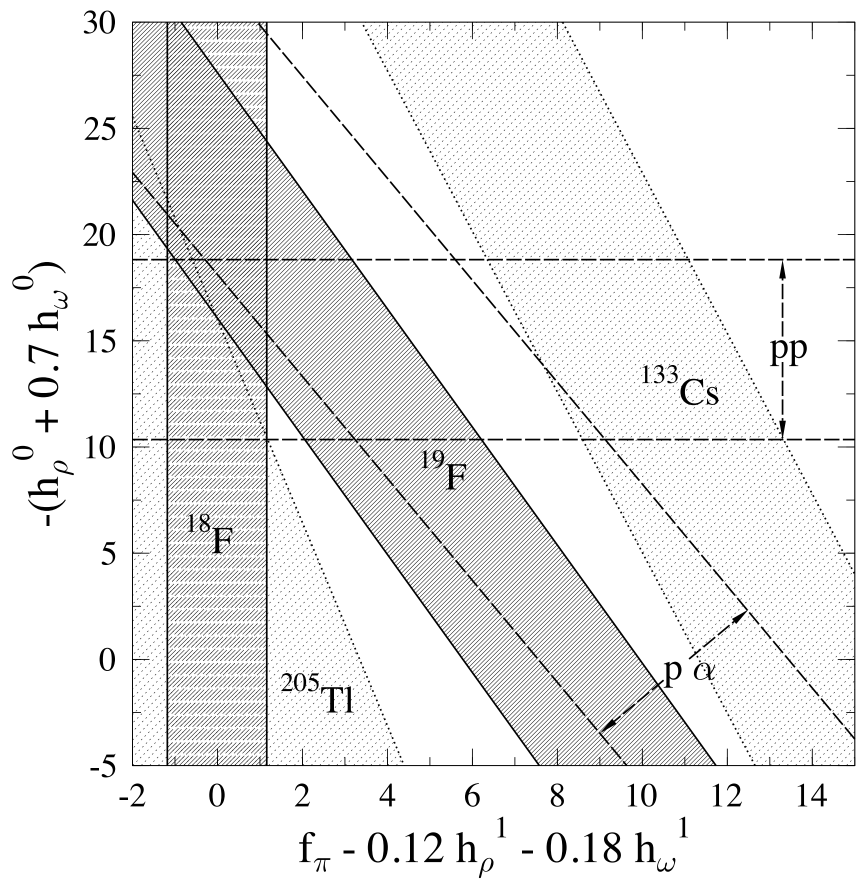

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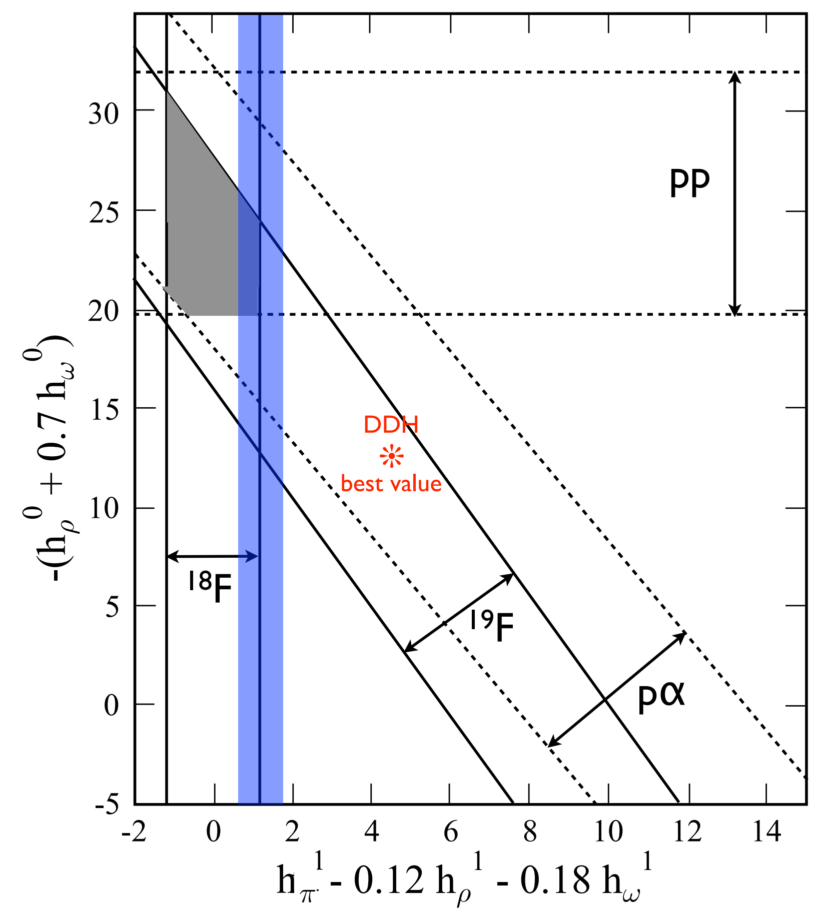

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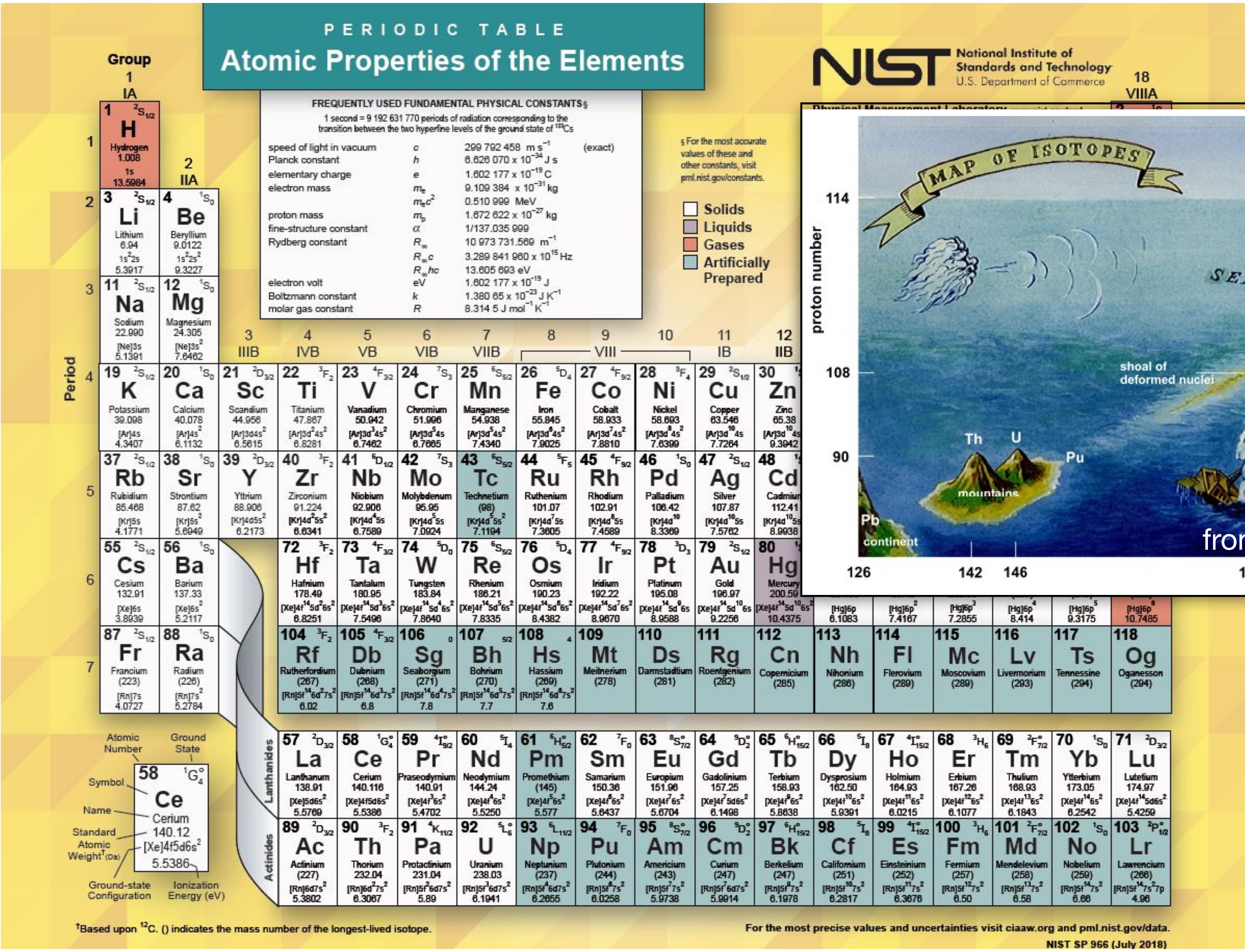
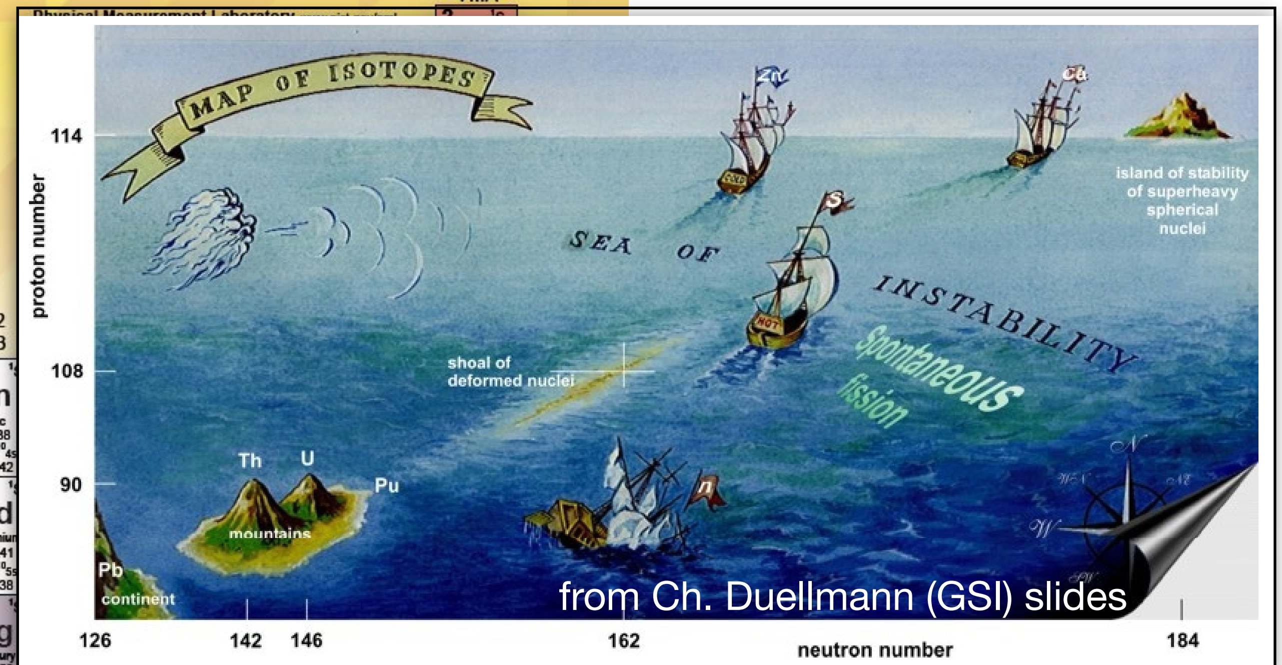
➤ results from Cs and Tl anapole moments not considered reliable due to complex nuclear polarizability corrections

Superheavy elements





- ➤ synthesis of new elements @ GSI Darmstadt and RIKEN
  - ➤ Hinde and Dasgupta — nuclear fusion reactions DP
- ➤ superheavy atomic physics and chemistry — experiment and theory

Hyperfine structure, anomalies, nuclear moments

nuclear magnetic moments

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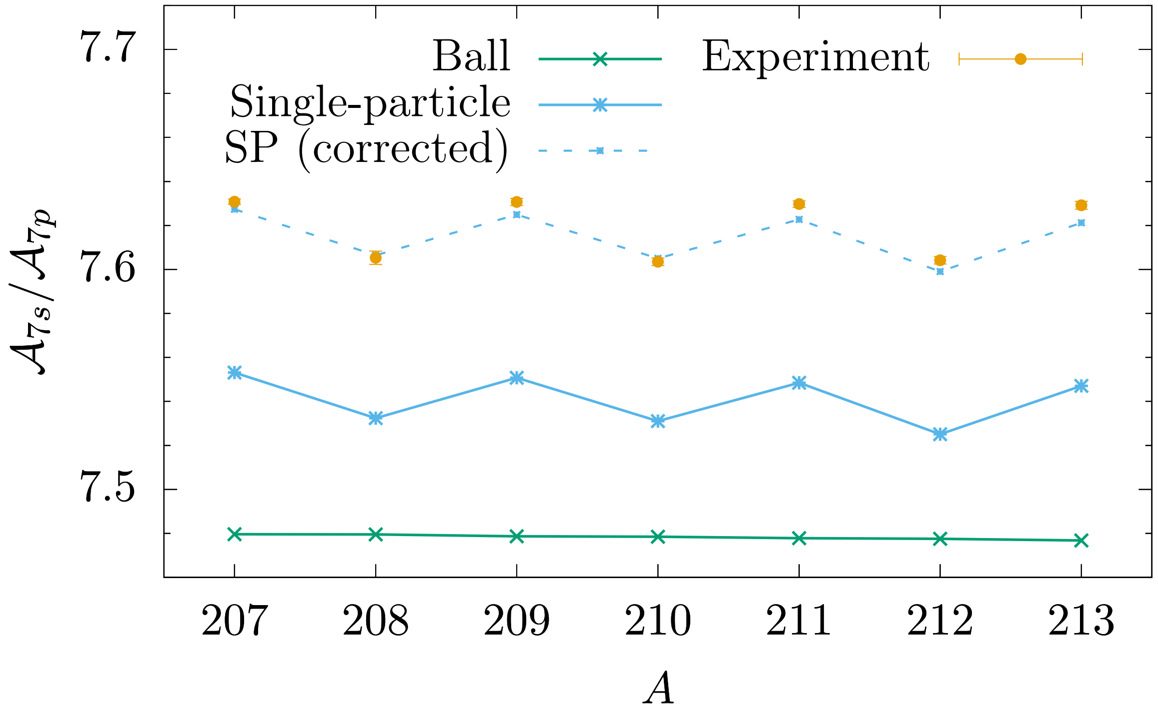
A(7*s*)/*A*(7*p*$_{1/2}$) vs atomic mass for francium



Roberts and Ginges (2000)

Hyperfine anomaly

magnetic hyperfine anomaly

Hyperfine constant $\mathcal{A} = \mathcal{A}_0(1+\epsilon) + \delta\mathcal{A}_{\mathrm{QED}}$

Ratio of hyperfine constants of different isotopes of the same element

$$\mathcal{A}^{(1)}/\mathcal{A}^{(2)} = g_I^{(1)}/g_I^{(2)}(1 +^1 \Delta^2)$$

Typically for nuclei of different spin, $^1\Delta^2 \approx \epsilon^{(1)} - \epsilon^{(2)}$

[Collaborating with M. Kowalska (CERN-ISOLDE) and J. Dobacewski (York)]

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