

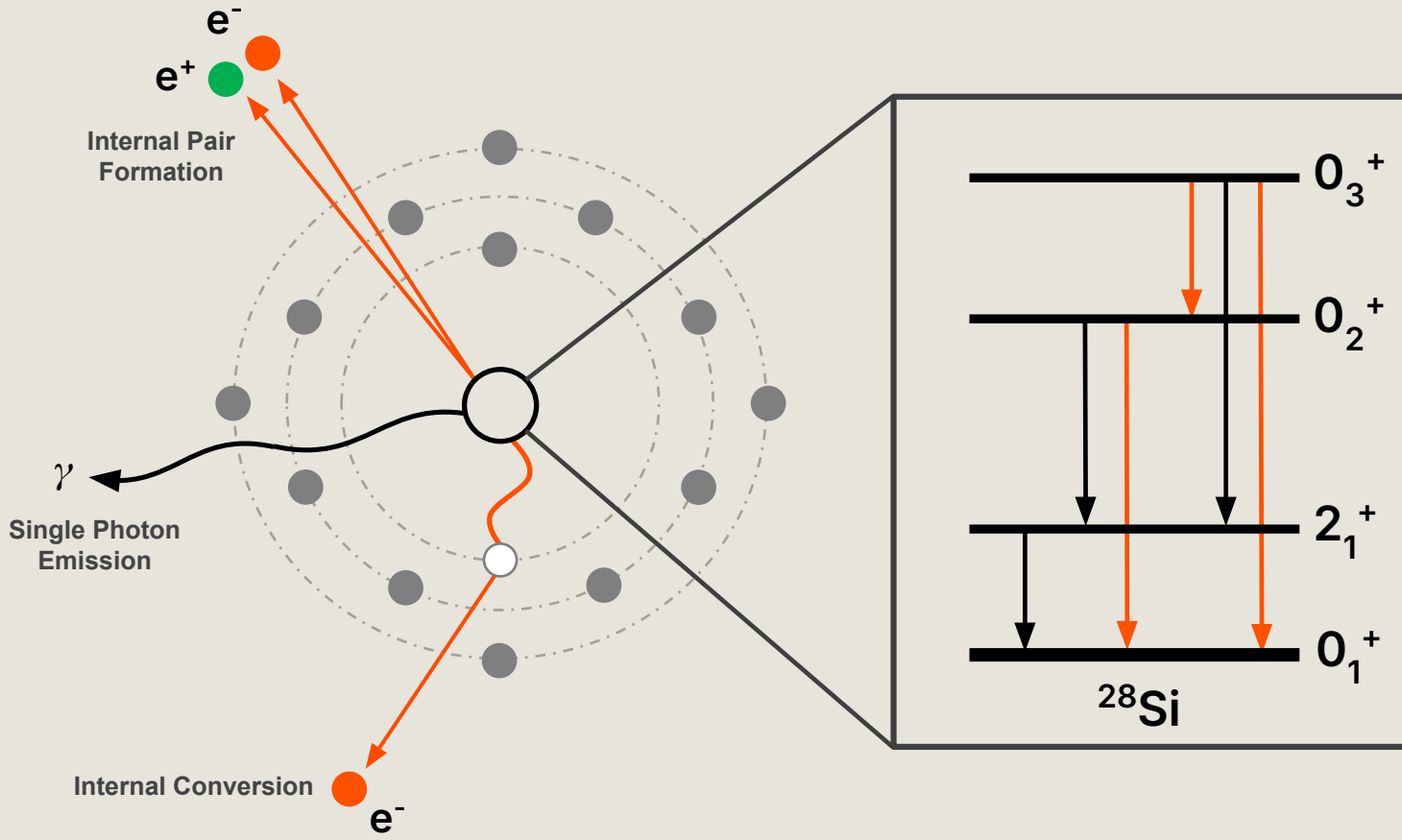
Direct Measurements of Low-Lying Monopole Transitions in ^{28}Si

April 2026

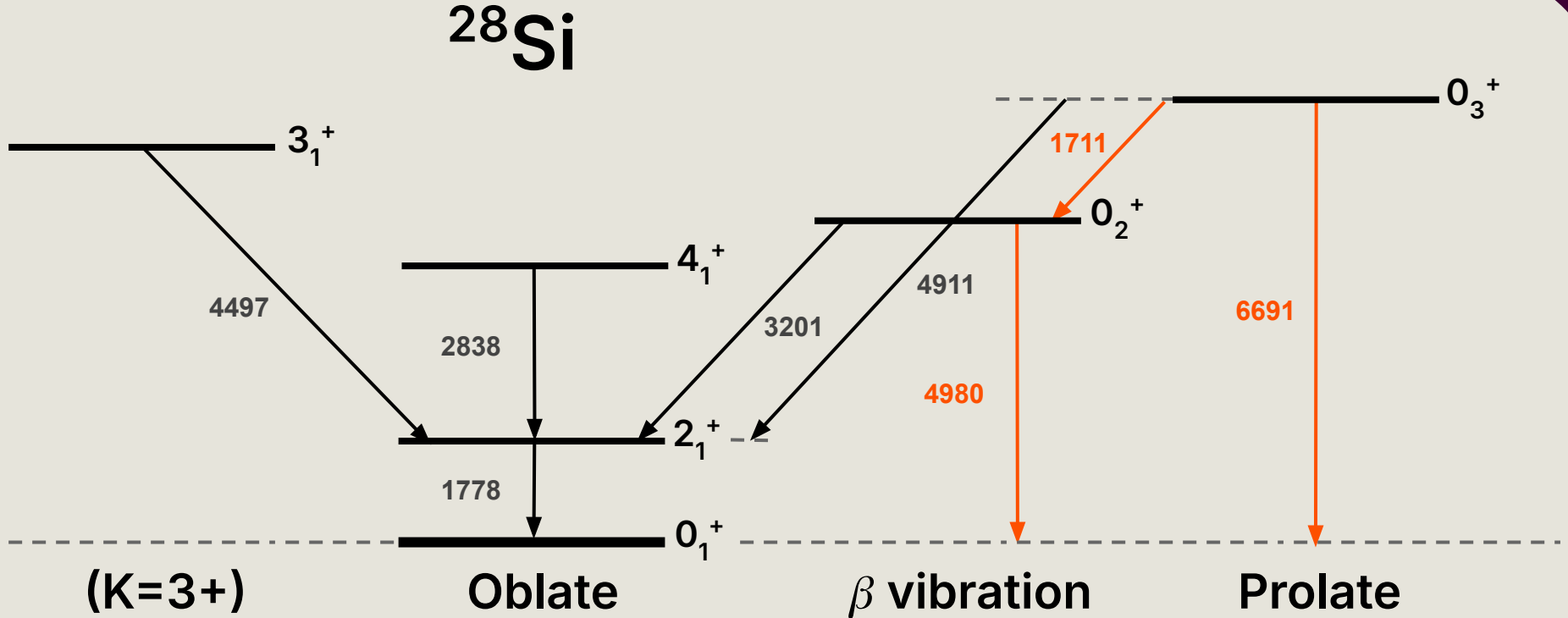


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E0 transitions - a quick review



Why ^{28}Si ?



D. G. Jenkins *et al.*, Phys. Rev. C **86** 064308 (2012)

D. Frycz *et al.*, Phys. Rev. C **110** 054326 (2024)

How did we decide what to do?

Previous Works:

- P. Strehl, Z. Phys. **234** 416 (1970)
- P. Adsley et al., Phys. Rev. C **95** 024319 (2017)

- M. Boromiza *et al.*, Phys. Rev. C **101** 024604 (2020)

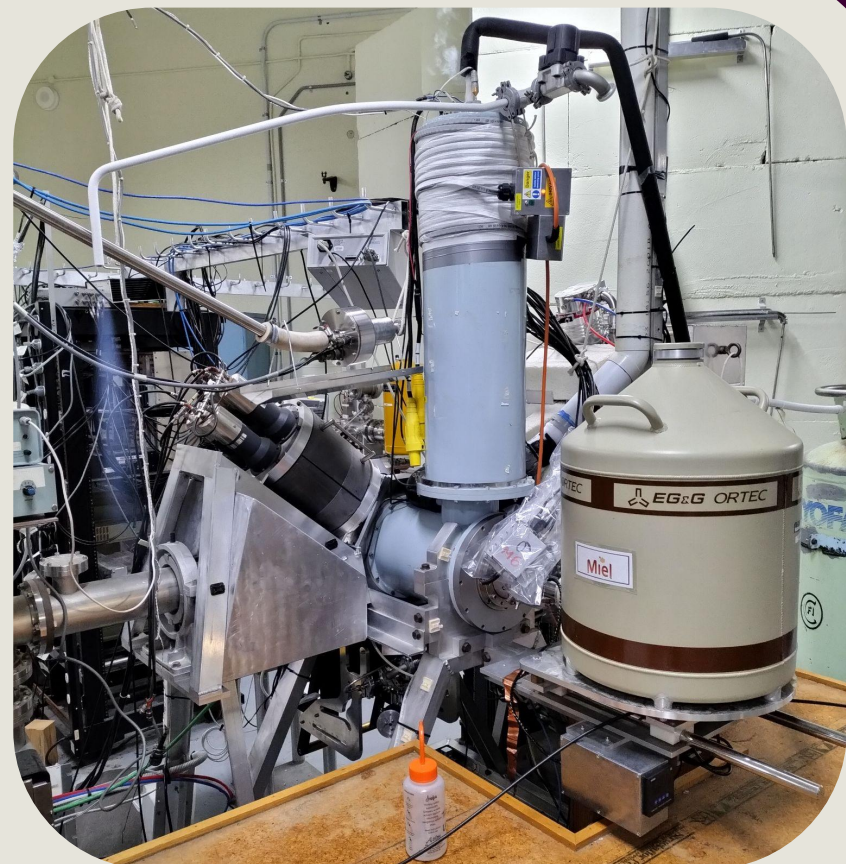
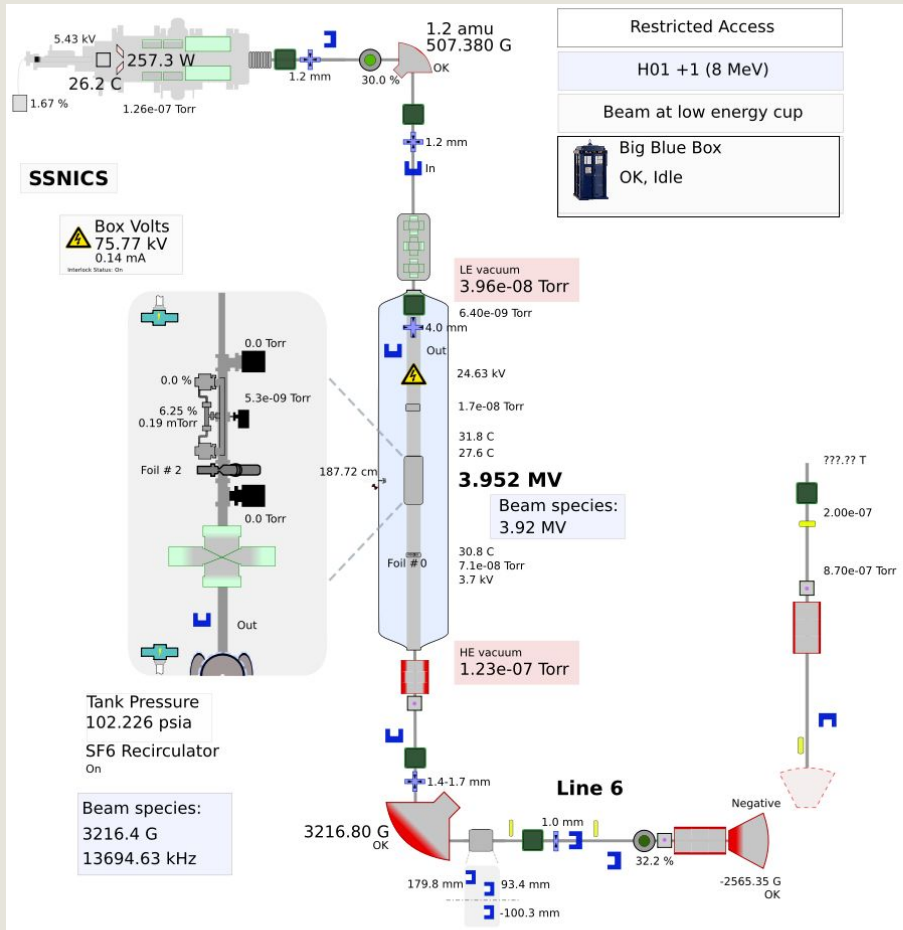
Our Measurements:

- Two experiments - Nov 2023 and Apr 2025
- 8 MeV protons
- $1.63 \text{ mg cm}^{-2} \text{ natSi}$ targets

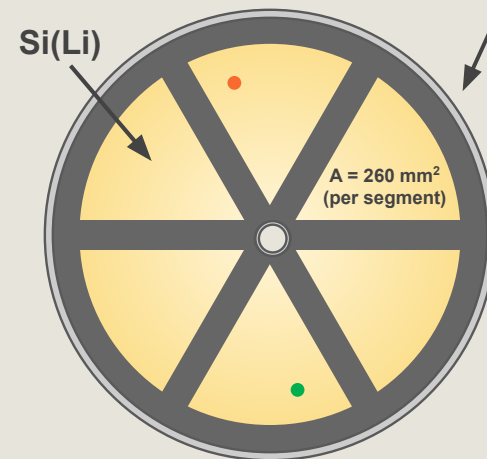
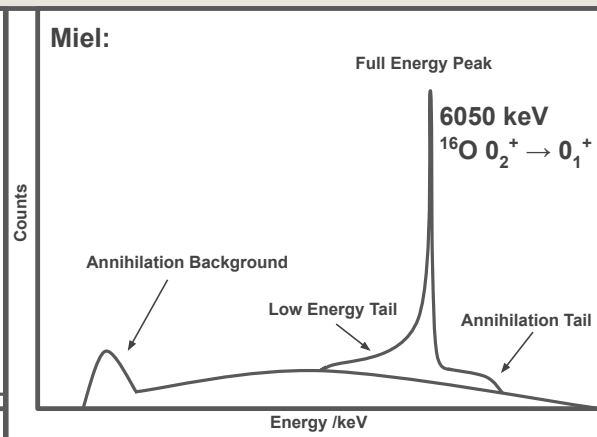
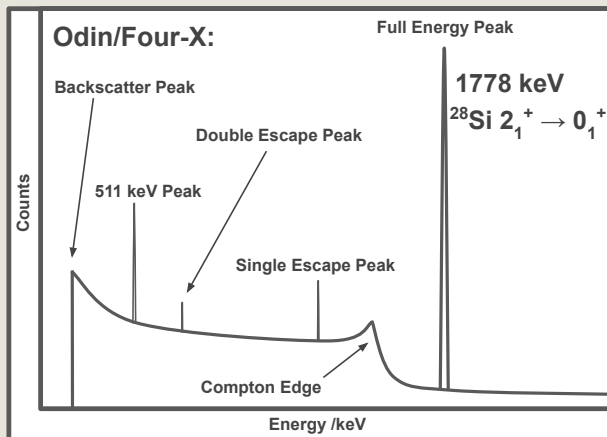
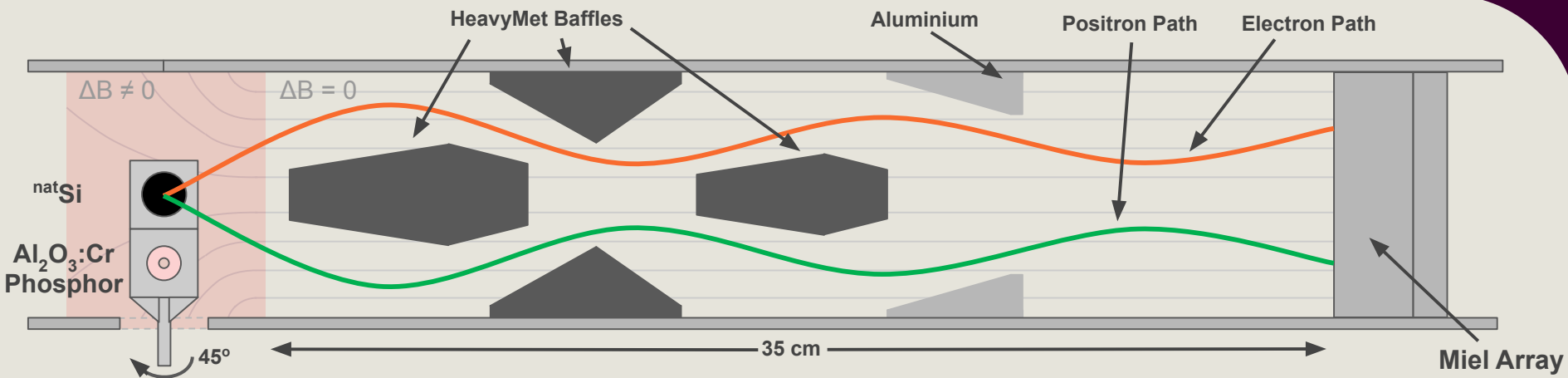
Completed at the Heavy Ion Accelerator Facility (HIAF)
at the Australian National University (ANU)



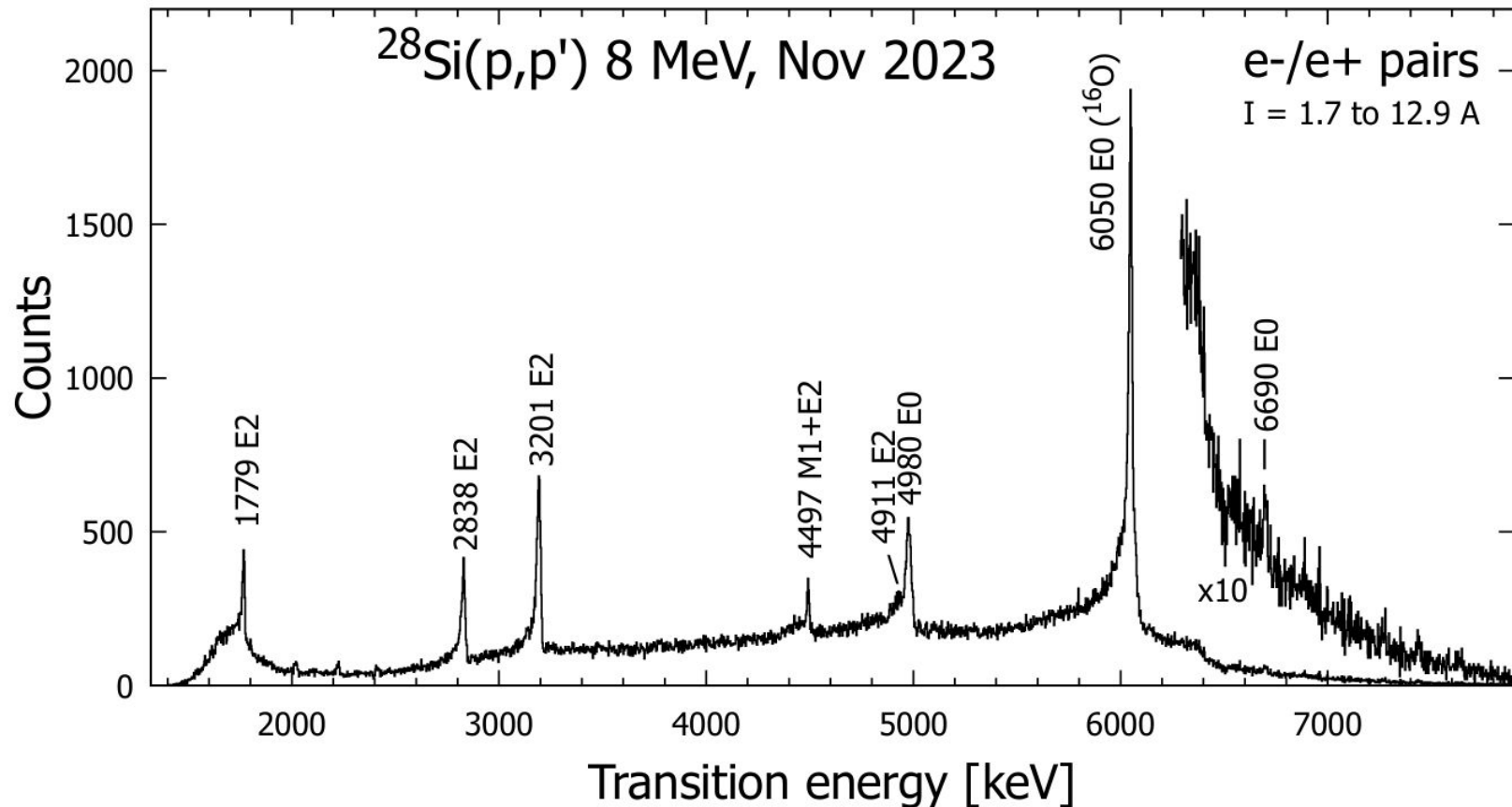
The 14UD



The Super-e



So what do we see?



Monopole Transition Strengths

The most important thing to extract is the dimensionless monopole transition strength,

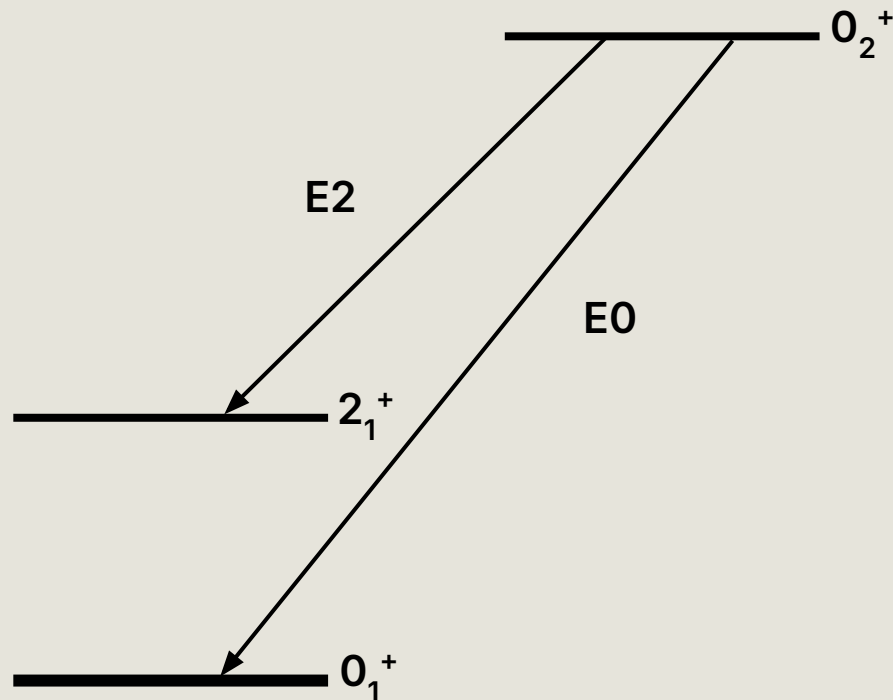
$$\rho(E0) = \frac{\langle i|M(E0)|f\rangle}{eR^2}$$

where R is the nuclear radius and $M(E0)$ is the monopole matrix element. This contains **all** of the information about the structure of the nucleus. From our data we can extract the square,

$$\rho^2(E0) = \frac{1}{\Omega_T(E0) \cdot \tau(E0)}$$

where $\Omega_T(E0)$ is the sum of the conversion and pair formation electronic factors and $\tau(E0)$ is the partial lifetime of the $E0$ transition.

Consider the ideal case:



$$\tau(E0) = \frac{I_T(E2) + I_T(E0)}{I_T(E0)} \cdot T_{1/2}(0^+)$$

$$I_T(E2) = I_\gamma(E2) + I_{CE}(E2) + I_\pi(E2)$$

$$I_T(E2) = \frac{A_\pi(E2)}{\xi_\pi(E2)} \cdot \frac{(1 + \alpha_T(E2))}{\alpha_\pi(E2)}$$

$$I_T(E0) = I_{CE}(E0) + I_\pi(E0)$$

$$I_T(E0) = \frac{A_\pi(E0)}{\xi_\pi(E0)} \cdot \frac{\Omega_T(E0)}{\Omega_\pi(E0)}$$

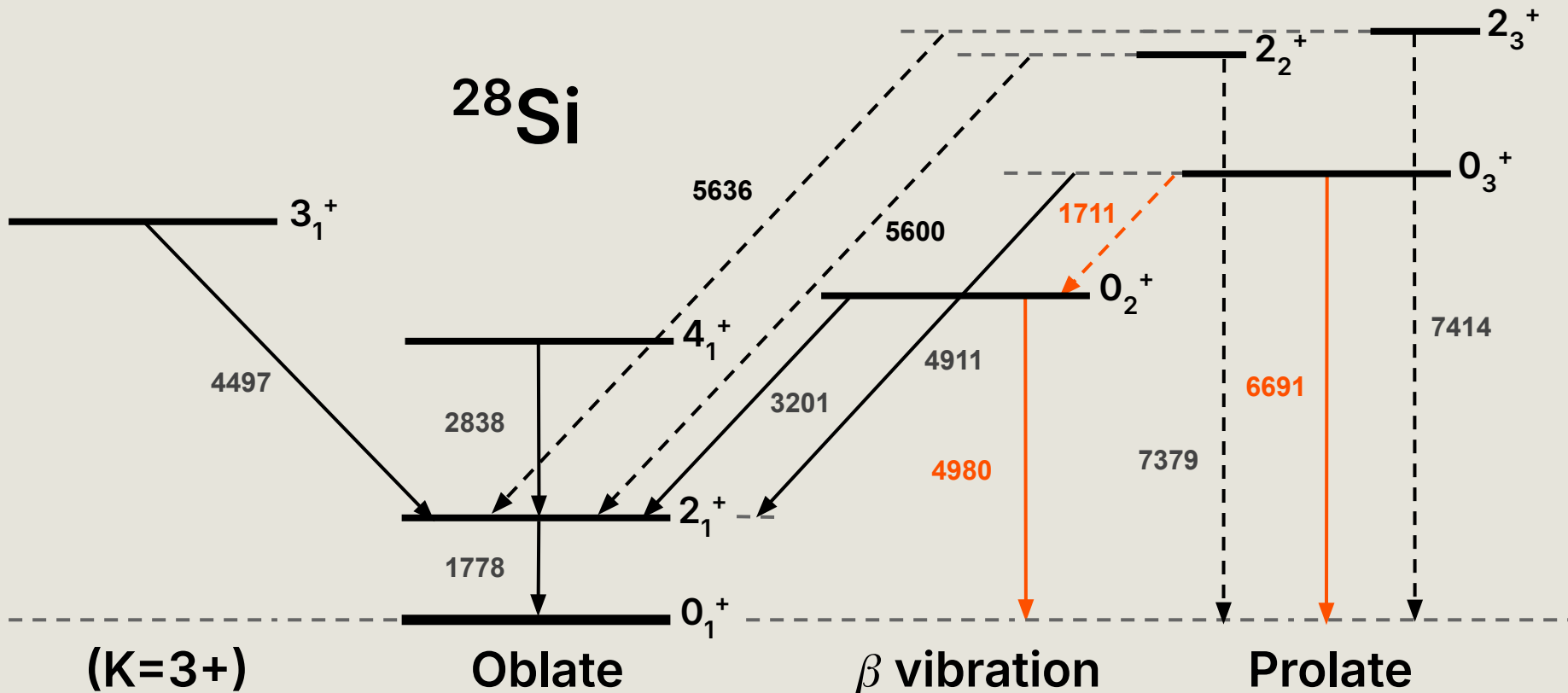
where I_T are our total intensities from single photon emission, internal conversion, and internal pair formation and $T_{1/2}$ is the half-life of the initial 0^+ state. A_π are our pair peak areas, ξ_π are simulated pair efficiencies for Miel, and α and Ω are conversion coefficients and electronic factors from BrICC, respectively. We can then relate the square of the monopole transition strength to the change in the r.m.s. charge radius, $\Delta\langle r^2 \rangle$, and the mixing amplitudes, α and β , between the initial and final states:

$$\rho^2(E0) = \frac{\alpha^2 \beta^2 (\Delta\langle r^2 \rangle)^2 Z^2}{R^4}$$

Transition	$0_2^+ \rightarrow 0_1^+$	$0_3^+ \rightarrow 0_1^+$
$\rho^2(E0) \times 10^3$	260 (40) ^a	-
	246 (25) ^b	5.9 (21) ^b
	340 (40) ^c	6.7 (26) ^c

^a P. Strehl, Z. Phys. **234** 416 (1970), ^b Nov 2023, ^c Apr 2025

Further States of Interest



D. G. Jenkins *et al.*, Phys. Rev. C **86** 064308 (2012)

Collaborators

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