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## Metastable Helium Atom Production by Positron Impact

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We have adapted one of the ANU positron beamlines, which use a Surko buffer gas trap and a strong magnetic field, to enable direct measurements of reaction products from atomic collision experiments. An effusive gas jet was added to the beamline, which allowed us to cross a helium beam with the high-resolution, pulsed positron beam. Long-lived (metastable) neutral excited helium atoms formed in the positron collisions were detected by a strategically positioned channel electron multiplier (CEM).

Helium has two long-lived metastable states ( $2^3S$  and  $2^1S$ ), though only the  $2^1S$  state is directly accessible to positrons. Excitation of the  $2^3S$  state requires a spin-flip from the ground state and since positrons do not have access to the exchange interaction like electrons, they instead require the spin-orbit interaction, which is both weaker for positrons than electrons and weak for helium in general (spin-orbit scales roughly with atomic number  $Z^4$ ). Thus, we expect only  $2^1S$  excitation.

In the experiment, a pulsed positron beam crosses a He beam and metastable atoms are detected with high efficiency ( $\sim 90\%$ ) by a CEM. Time-of-flight techniques and electrostatic retardation are used to separate the relatively slow He atoms from faster reaction products (ions, positrons, electrons, positroniums). The  $2^1S$  state has a lifetime of  $\sim 19$  ms, which is far longer than the average flight time of the atoms from the collision volume to the detector ( $\sim 40 \mu s$ ).

Excitation of the He  $2^1S$  state as a function of incident positron energy will be presented and compared with previous measurements using conventional gas-cell arrangements and with theory.

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