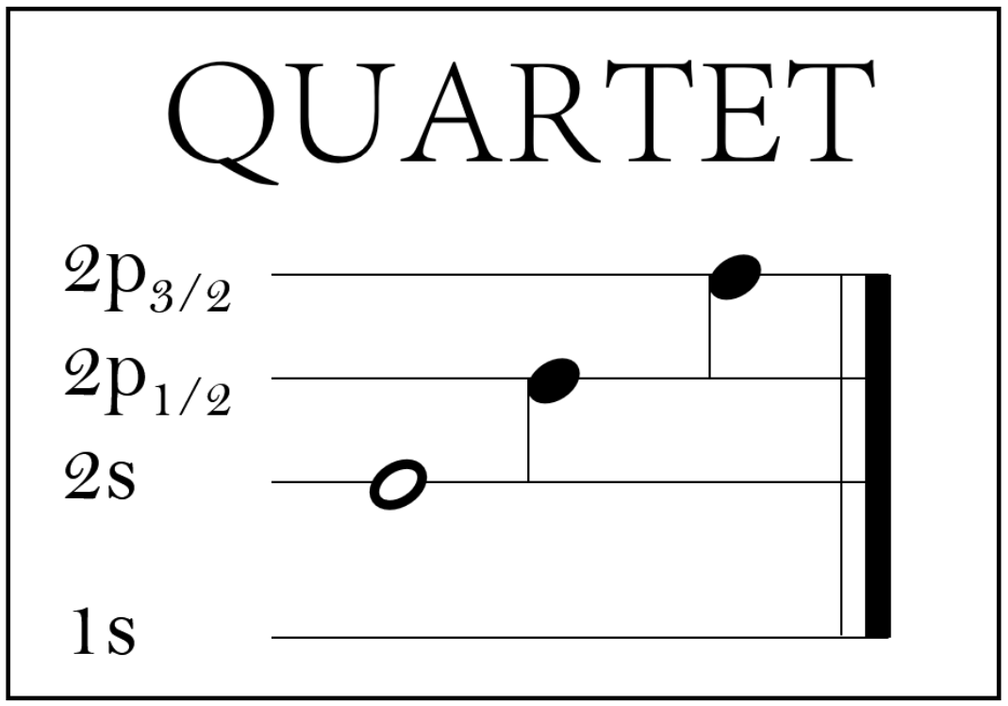

News and Views

Monthly Collaboration Meeting

March 27, 2023

News and Views

1. Discussion with ab initio nuclear theorists (March 21st)
   - Petr Navratil (Triumf) No Core Shell Model with Continuum (NCSMC)
   - Existing calculations (i.e. wavefunctions) for almost all the nuclei we plan to measure
   - Radii can be extracted easily, they have never published NCSMC radii before
   - Good test of different interactions with NCSMC
   - Control many-body approach by comparing with S. Bacca calculations
   - Can get TPE from NCSM
   - Collaboration: P. Navratil (TRIUMF), S. Quaglioni (LLNL), G. Hupin (Orsay), C. Hebborn (FRIB)
   - **Accept to join QUARTET**

Next steps:
-NCSMC collab. will present at a QUARTET monthly meeting
-Organize a theory workshop in Paris

PHYSICAL REVIEW LETTERS **129,** 042503 (2022)

Ab Initio Prediction of the ^{4}He$(d,\gamma)^6$Li Big Bang Radiative Capture

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The rate at which helium (^{4}He) and deuterium (d) fuse together to produce lithium-6 (^{6}Li) and a γ ray, ^{4}He$(d,\gamma)^6$Li, is a critical puzzle piece in resolving the discrepancy between big bang predictions and astronomical observations for the primordial abundance of ^{6}Li. The accurate determination of this radiative capture rate requires the quantitative and predictive description of the fusion probability across the big bang energy window (30 keV $\lesssim E \lesssim$ 400 keV), where measurements are hindered by low counting rates. We present first-principle (or, *ab initio*) predictions of the ^{4}He$(d,\gamma)^6$Li astrophysical S factor using validated nucleon-nucleon and three-nucleon interactions derived within the framework of chiral effective field theory. By employing the *ab initio* no-core shell model with continuum to describe ^{4}He-d scattering dynamics and bound ^{6}Li product on an equal footing, we accurately and consistently determine the contributions of the main electromagnetic transitions driving the radiative capture process. Our results reveal an enhancement of the capture probability below 100 keV owing to previously neglected magnetic dipole ($M1$) transitions and reduce by an average factor of 7 the uncertainty of the thermonuclear capture rate between 0.002 and 2 GK.

DOI: 10.1103/PhysRevLett.129.042503

News and Views

2. Discussion with T. Azuma (HEATES collaboration, J-PARC)
   - Muonic Ne paper accepted to PRL
   - 2 new TES detectors arriving in 2023 for 50 and 100 keV
   - Muonic Ar QED test in early 2024
   - They want to use the 100 keV detector measure charge radii at JPARC
   - **First case is Si**
   - They want collaborative and not competitive approach with QUARTET

Accepted Paper

Proof-of-principle experiment for testing strong-field quantum electrodynamics with exotic atoms: High precision x-ray spectroscopy of muonic neon

Phys. Rev. Lett.

T. Okumura et al.

Accepted 10 March 2023

ABSTRACT

ABSTRACT

To test bound-state quantum electrodynamics (BSQED) in the strong-field regime, we have performed high-precision x-ray spectroscopy of the $5g$-$4f$ and $5f$-$4d$ transitions (BSQED contribution of and , respectively) of muonic neon atoms in the low-pressure gas phase without bound electrons. Muonic atoms have been recently proposed as an alternative to few-electron high-Z ions for BSQED tests by focusing on circular Rydberg states where nuclear contributions are negligibly small. We determined the $5g_{9/2}$-$4f_{7/2}$ transition energy to be 6297.08 $\pm$ 0.04 (stat.) $\pm$ 0.13 (syst.)~eV using superconducting transition-edge sensor microcalorimeters (5.2-5.5 eV FWHM resolution), which agrees well with the most advanced BSQED theoretical prediction of .