Resonance states of ^{23}Na and the ^{22}Ne(p,gamma)^{23}Na reaction

Diana P Carrasco-Rojas,[1] M Williams,[2] P Adsley[3,4]
[1]*University of Texas at El Paso, El Paso, TX 79968, USA*
[2]*TRIUMF, Vancouver, BC V6T 2A3, Canada*
[3]*Cyclotron Institute, Texas A&M University, College Station, Texas 77843, USA*
[4]*Department of Physics and Astronomy, Texas A&M University, College Station, Texas 77843*

The ^{22}Ne(p,gamma)^{23}Na reaction has a significant impact on the sodium-oxygen anticorrelation in globular clusters. Previous experimental studies with the DRAGON recoil separator and using a proton beam on a ^{22}Ne gas target at the Laboratory for Underground Nuclear Astrophysics (LUNA) at Gran Sasso, Italy, have located and measured a number of resonances of the ^{2}Ne(p,gamma)^{23}Na reaction. However, two resonances at E_r = 68 and 10 keV (E_x = 8862 and 8894 keV), which were assigned following a weak population in ^{22}Ne(^{3}He,d)^{23}Na single-proton transfer reactions, have eluded direct measurement. Unfortunately, their low energy means that these are the dominant resonances for much of the Hot-Bottom Burning region of intermediate-mass asymptotic giant branch stars.

Low-energy proton scattering is a powerful technique for populating excited states in nuclei without much sensitivity to the underlying structure of the state. In this experiment we used the Munich

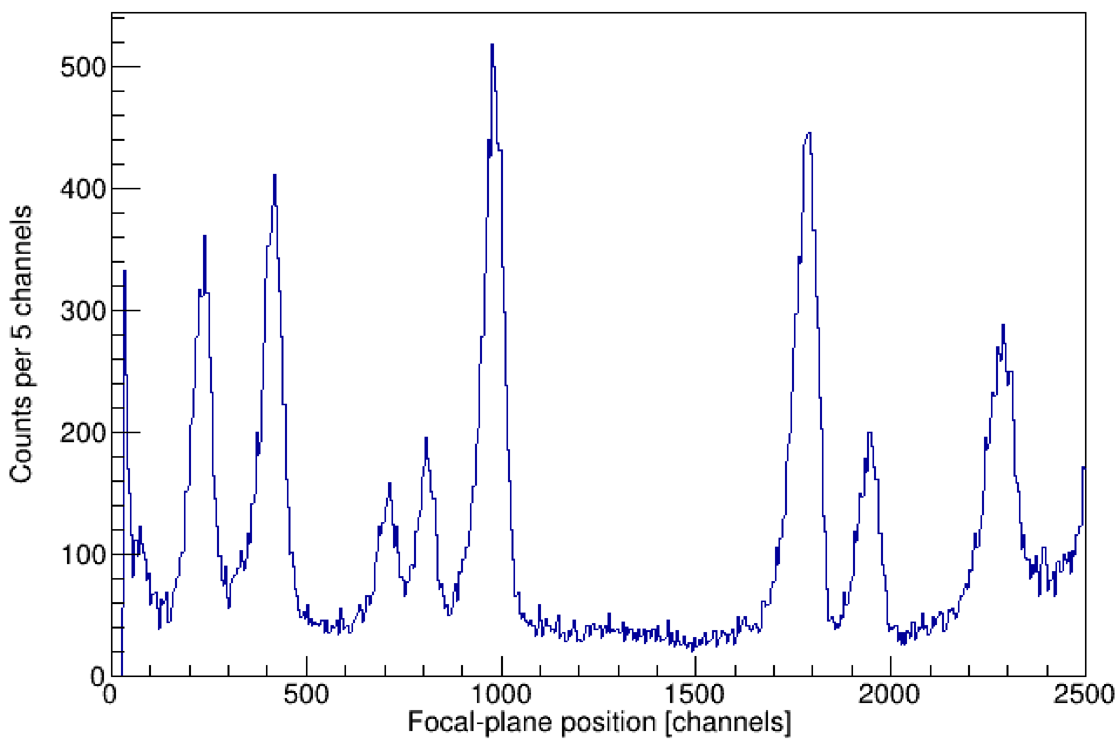

Fig. 1. Excitation-energy spectrum taken at 70 degrees scattering angle using a NaF target with states in ^{23}Na, ^{19}F, ^{16}O and ^{12}C populated on the focal plane. The region of interest is approximately between channels 1000 and 1500.

Q3D magnetic spectrometer and a 14-MeV beam of protons on a $^{23}Na^{19}F$ target to populate the excited resonance states in ^{23}Na which dominate the ^{22}Ne(p,gamma) reaction rate. A focal-plane spectrum for the reaction is shown in the figure below. In the region of interest there is no indication that the tentative resonance states exist, meaning that it is unlikely that they can contribute to the ^{22}Ne(p,gamma) reaction. This greatly reduces some of the remaining causes of uncertainty in the ^{22}Ne(p,gamma) reaction, and means that future direct measurements are likely not required.