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Direct capture cross section and low-energy resonances in the 22Ne(p,gamma)23Na reaction

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The 22Ne(p,gamma)23Na reaction takes part in the neon-sodium cycle of hydrogen burning and may affect the observed anticorrelation between sodium and oxygen abundances in globular cluster stars. Its rate is controlled by a number of low-energy resonances and a slowly varying non-resonant component. Three new resonances at Ep = 156.2, 189.5, and 259.7 keV, respectively, have recently been observed and confirmed. However, significant uncertainty remains due to the off-resonant process and two hypothetical resonances at Ep = 71 and 105 keV, respectively. Here, new data with unprecedented high luminosity and low background on these aspects of the 22Ne(p,gamma)Na reaction are reported. Stringent upper limits are placed on the two hypothetical resonances, ruling them out for astrophysical purposes. The off-resonant yield has been measured at unprecedented low energy, constraining the contributions from a subthreshold resonance and the direct capture process. The 22Ne(p,gamma)23Na reaction rate, which used to be the most uncertain rate of the neon-sodium cycle, is now the best known rate.

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