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

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The ^{22}Ne(p,γ)^{23}Na 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 E_p = 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 E_p = 71 and 105 keV, respectively. Here, new data with unprecedented high luminosity and low background on these aspects of the ^{22}Ne(p,γ)^{23}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 ^{22}Ne(p,γ)^{23}Na reaction rate, which used to be the most uncertain rate of the neon-sodium cycle, is now the best-known rate.