Segue 3: An Old, Extremely Low luminosity Star Cluster in the Milky Way's Halo

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We investigate the kinematic and photometric properties of the Segue 3 Milky Way companion using Keck/DEIMOS spectroscopy and Magellan/IMACS g and r-band imaging. Using maximum likelihood methods to analyze the photometry, we study the structure and stellar population of Segue 3. We find the half-light radius of Segue 3 is 26" +/- 5" (2.1 +/- 0.4 pc, for a distance of 17 kpc) and the absolute magnitude is a mere M_V = 0.0 +/- 0.8 mag, making Segue 3 the least luminous old stellar system known. We find Segue 3 to be consistent with a single stellar population, with an age of 12.0 +1.5/-0.4 Gyr and an [Fe/H] of -1.7 +0.07/-0.27. Line-of-sight velocities from the spectra are combined with the photometry to determine a sample of 32 stars which are likely associated with Segue 3. The member stars within three half-light radii have a velocity dispersion of 1.2 +/- 2.6 km/s. Photometry of the members indicates the stellar population has a spread in [Fe/H] of <0.3 dex. These facts, together with the small physical size of Segue 3, imply the object is likely an old, faint stellar cluster which contains no significant dark matter. We find tentative evidence for stellar mass loss in Segue 3 through the eleven candidate member stars outside of three half-light radii, as expected from dynamical arguments. Interpretation of the data outside of three half-light radii, is complicated by the object's spatial coincidence with a previously known halo substructure, which may enhance contamination of our member sample.

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