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J/ApJ/784/170 The SEGUE K giant survey. II. Distances of 6036 stars (Xue+, 2014)

The SEGUE K giant survey. II. A catalog of distance determinations for the SEGUE K giants in the galactic halo.

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Abstract:

We present an online catalog of distance determinations for 6036 K giants, most of which are members of the Milky Way's stellar halo. Their medium-resolution spectra from the Sloan Digital Sky Survey/Sloan Extension for Galactic Understanding and Exploration are used to derive metallicities and rough gravity estimates, along with radial velocities. Distance moduli are derived from a comparison of each star's apparent magnitude with the absolute magnitude of empirically calibrated color-luminosity fiducials, at the observed $(g-r)_0$ color and spectroscopic [Fe/H]. We employ a probabilistic approach that makes it straightforward to properly propagate the errors in metallicities, magnitudes, and colors into distance uncertainties. We also fold in prior information about the giant-branch luminosity function and the different metallicity distributions of the SEGUE K-giant targeting sub-categories. We show that the metallicity prior plays a small role in the distance estimates, but that neglecting the luminosity prior could lead to a systematic distance modulus bias of up to 0.25mag, compared to the case of using the luminosity prior. We find a median distance precision of 16%, with distance estimates most precise for the least metal-poor stars near the tip of the red giant branch. The precision and accuracy of our distance estimates are validated with observations of globular and open clusters. The stars in our catalog are up to 125kpc from the Galactic center, with 283 stars beyond 50kpc, forming the largest available spectroscopic sample of distant tracers in the Galactic halo.

Description:

SDSS and its extensions use a dedicated 2.5m telescope to obtain ugriz imaging and resolution (defined as $R=\lambda/\Delta\lambda$)-2000 spectra for 640 (SDSS spectrograph) or 1000 (BOSS spectrograph) objects over a 7deg² field. Sloan Extension for Galactic Understanding and Exploration (SEGUE), one of the key projects executed during SDSS-II and SDSS-III, obtained some 360000 spectra of stars in the Galaxy, selected to explore the nature of stellar populations from 0.5kpc to 100kpc (Yanny et al. 2009, cat. [J/AJ/137/4377](#); and C. M. Rockosi et al., in preparation). Data from SEGUE is a significant part of the ninth SDSS public data release (DR9; Ahn et al. 2012, cat. [V/139](#)).

The SEGUE project obtained spectra for a large number of different stellar types: 18 for SEGUE-1 (see Yanny et al. 2009, cat. [J/AJ/137/4377](#), for details) and 11 for SEGUE-2 (C. M. Rockosi et al. in preparation). Three of these target types were specifically designed to detect K giants: these are designated "l-color K giants", "red K giants", and "proper-motion K giants." The K-giant targets from these three categories all have $0.5 < (g-r)_0 < 1.3$, $0.5 < (u-g)_0 < 3.5$, and proper motions smaller than 11mas/yr.

We present a catalog containing the distance moduli, observed information, and SEGUE Stellar Parameter Pipeline (SSPP) atmospheric parameters for 6036 SEGUE K giants (see Table4). For each object in the catalog, we also list some of the basic observables such as (R.A., decl.), extinction-corrected apparent magnitudes and dereddened colors, as well as the information obtained from the spectra--heliocentric radial velocities plus SSPP atmospheric parameters. In addition, we provide the Bayesian estimates of the distance moduli, distances to the Sun, Galactocentric distances, the absolute magnitudes and their uncertainties, along with the distance moduli at (5%, 16%, 50%, 84%, 95%) confidence of L(DM).

File Summary:

FileName	Lrecl	Records	Explanations
ReadMe	80	.	This file
table2.dat	19	1000	Interpolated fiducial
table4.dat	158	6036	List of 6036 K giants selected from SDSS DR9

See also:

- [V/139](#) : The SDSS Photometric Catalog, Release 9 (Adelman-McCarthy+, 2012)
[VII/202](#) : Globular Clusters in the Milky Way (Harris, 1997)
[J/ApJ/738/79](#) : SDSS-DR8 BHB stars in the Milky Way's halo (Xue+, 2011)
[J/ApJ/731/4](#) : Galactic halo as seen by the CFHTLS (Sesar+, 2011)
[J/AJ/141/90](#) : SEGUE stellar parameter pipeline. V. (Lee+, 2011)
[J/AJ/141/89](#) : SEGUE stellar parameter pipeline. IV. (Smolinski+, 2011)
[J/AJ/137/4377](#) : List of SEGUE plate pairs (Yanny+, 2009)
[J/AJ/136/2070](#) : SEGUE stellar parameter pipeline. III. (Allende Prieto+, 2008)
[J/AJ/136/2050](#) : SEGUE stellar parameter pipeline. II. (Lee+, 2008)
[J/ApJ/684/1143](#) : BHB candidates in the Milky Way (Xue+, 2008)
[J/AJ/125/2502](#) : Spectral indices of Galactic halo (Morrison+, 2003)
[J/AJ/100/1191](#) : Giants DDO photometry (Morrison+, 1990)

Byte-by-byte Description of file: [table2.dat](#)

Bytes	Format	Units	Label	Explanations
1– 5	F5.3	mag	g-r	[0.3/1.4] Extinction-corrected color index (g-r) ₀
7– 12	F6.3	mag	rMag	[-3.4/3] Absolute magnitude in r band (M _r)
14– 19	F6.3	[-.]	[Fe/H]	[-2.4/0.4] Metallicity

Byte-by-byte Description of file: [table4.dat](#)

Bytes	Format	Units	Label	Explanations
1– 8	F8.4	deg	RAdeg	Right Ascension in decimal degrees (J2000)
10– 17	F8.4	deg	DEdeg	Declination in decimal degrees (J2000)
19– 24	F6.3	mag	r _{mag}	[13.8/19.6] Extinction-corrected r band magnitude (r ₀)
26– 30	F5.3	mag	e_rmag	[0.037/0.053] Error in r _{mag} (Δr ₀) (.1)
32– 36	F5.3	mag	g-r	[0.5/1.3] The (g-r) color index after extinction correction (g-r) ₀
38– 42	F5.3	mag	e_g-r	[0.018/0.044] Error in g-r (Δ(g-r) ₀) (.1)
44– 49	F6.1	km/s	HRV	[-506.5/419.4] Heliocentric radial velocity
51– 54	F4.1	km/s	e_HRV	[0.5/15.1] Error in HRV
56– 59	I4	K	Teff	[4025/5691] Effective temperature (SSPP) (.2)
61– 65	F5.2	[-.]	[Fe/H]	[-3.6/0.32] Metallicity (SSPP) (.2)
67– 70	F4.2	[-.]	e_[Fe/H]	[0.1/0.23] Error in [Fe/H] (.3)
72– 75	F4.2	[cm/s2]	logg	[0.18/3.5] Log of the surface gravity (SSPP) (.2)
77– 81	F5.2	mag	DMpeak	[13.1/20.4] Distance modulus at peak of distance modulus likelihood (DM _{peak}) (.4)
83– 87	F5.2	mag	DM05	[12.2/20.3] Distance modulus at 5% confidence of distance modulus likelihood (DM _{5%}) (.4)
89– 93	F5.2	mag	DM16	[12.6/20.3] Distance modulus at 16% confidence of distance modulus likelihood (DM _{16%}) (.4)
95– 99	F5.2	mag	DM50	[13/20.4] Distance modulus at 50% confidence of distance modulus likelihood (DM _{50%}) (.4)
101–105	F5.2	mag	DM84	[13.5/20.5] Distance modulus at 84% confidence of distance modulus likelihood (DM _{84%}) (.4)
107–111	F5.2	mag	DM95	[13.7/20.6] Distance modulus at 95% confidence of distance modulus likelihood (DM _{95%}) (.4)
113–116	F4.2	mag	eDM	[0.05/0.76] Error in distance modulus estimate (ΔDM) (.5)
118–122	F5.2	mag	rMag	[-3.2/1.2] Absolute magnitude in r band (M _r) (.6)
124–127	F4.2	mag	e_rMag	[0.07/0.8] Error in rMag (ΔM _r)
129–134	F6.2	kpc	Dist	[4.2/120.3] Distance to Sun (d) (.6)
136–140	F5.2	kpc	e_Dist	[0.5/16.6] Error in Dist (Δd)
142–147	F6.2	kpc	Rgc	[4.79/125.1] Distance to Galactic center (r _{GC}) (.6)
149–153	F5.2	kpc	e_Rgc	[0/16.47] Error in Rgc (Δr _{GC})
155–158	F4.2	---	pRGB	[0.45/1] Chance of being clearly on the Red-Giant Branch (RGB), above the level of the Horizontal Branch (HB) (P _{aboveHB}) (.7)

Note (1): Corrected for measurement errors on the photometry and reddening (see Section 2).

Note (2): SDSS DR9 delivers estimates of T_{eff}, logg, [Fe/H], and [α/Fe] from an updated and improved version of the SEGUE Stellar Parameter Pipeline (SSPP; Lee et al. [2008AJ....136.2022L](#); Lee et al. 2008, cat. [J/AJ/136/2050](#); Allende Prieto et al. 2008, cat. [J/AJ/136/2070](#); Smolinski et al. 2011, cat. [J/AJ/141/89](#); Lee et al. 2011, cat. [J/AJ/141/90](#)). The errors for T_{eff} and log(g) are published in SDSS DR9, so we recommend readers to download them directly from CasJob.

Note (3): Derived from Signal-to-Noise ratio (S/N), which is calibrated using

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cluster data plus repeat observations, as described in detail in Morrison et al. (in preparation).

Note (4): Distance moduli are derived from a comparison of each star's apparent magnitude with the absolute magnitude of empirically calibrated color-luminosity fiducials, at the observed $(g-r)_0$ color and spectroscopic $[Fe/H]$. See Section 3 in the text for more details. DM_{peak} is the best estimate of the distance modulus for the K giant.

Note (5): Calculated from $(DM_{84\%}-DM_{16\%})/2$.

Note (6): Calculated from DM_{peak} , assuming $R_{\odot}=8.0kpc$ (i.e., $rMag=rMag-DM_{peak}$, $d=10^{((DM+5)/5)}$).

Note (7): See Section 3.4 in the text for further details.

History:
From electronic version of the journal

References:
Janesh et al., Paper III [2016ApJ...816...80J](#), cat. [J/ApJ/816/80](#)

(End) Prepared by [AAS]; Sylvain Guehenneux [CDS] 03-Aug-2016

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