A PAndAS cub in a stream – Andromeda XXVII and the North West Stream

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We present our analysis of 38 RGB stars in 7 fields spanning the centre of Andromeda XXVII (And XXVII) and the upper section of the NW stream (NW-K1).

And XXVII is a small, r_h ~455 pc, dSph galaxy lying ~86 kpc to the north-west of M31, with M_v = -7.9. It is co-located with NW-K1, which lies at a projected radius of 50-80 kpc from the centre of M31 and extends for ~ 3° on the sky, [1], see Figure 1.

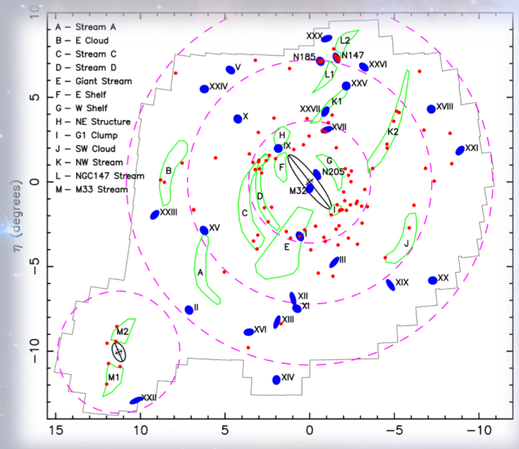


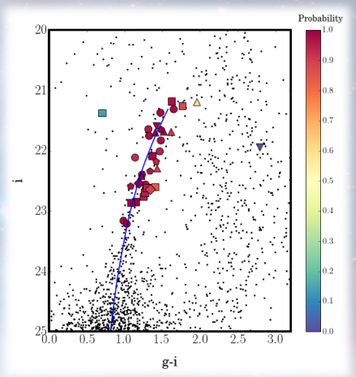
Figure 1: And XXVII and NW stream within the PAndAS footprint. Red dots = globular clusters. Blue ellipses = dwarf galaxies. Streams are outlined in green. Figure reproduced from [2]

Approach

To determine if And XXVII and NW-K1 are associated we confirm members of their stellar populations and determine their systemic velocities, velocity dispersions and metallicities. We derive the probability of membership of And XXVII/NW-K1 based on proximity to a fiducial isochrone (P_{iso}) and radial velocity (P_{vel}), with the overall probability given by $P_{tot} = P_{iso} \times P_{vel}$ and $P_{tot} > 0.6$.

We assess each star's probability of membership (P_{iso}) of And XXVII/NW-K1 based on their proximity to a fiducial isochrone, age = 12 Gyr, Fe/H = -1.7 and [α/H] = 0.0 from the Dartmouth Stellar Evolution database, [3], corrected for extinction and $D_\odot$ = 827 kpc.

Figure 2: CMD for And XXVII/NW-K1. The small black dots show stars from PAndAS within 5 arcmins of the centres of each field. Round icons represent candidate And XXVII/NW-K1 stars. M31 and MW contaminants are omitted for clarity.



We then determine probability of membership based on velocity (Pvel). We fit Gaussians to the data in each field, see Figure 3, and use the posterior distribution to determine the likelihood of membership.

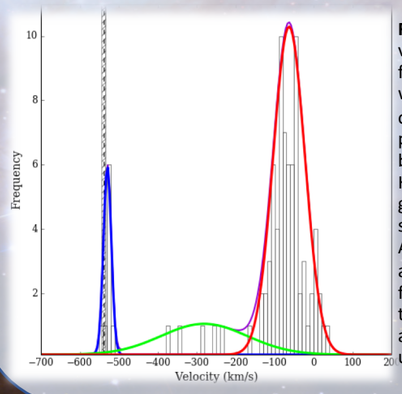
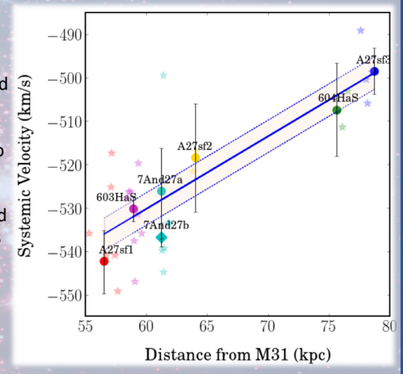


Figure 3: Example velocity histogram for field 603HaS overlaid with Gaussians for each of the three stellar populations - shown in blue for And XXVII/NW-K1, red for M31 and green for the MW. The systemic velocity of And XXVII is shown by a solid black line flanked by dotted lines that indicate the upper and lower uncertainties.

When we plot the systemic velocities from each field, we see (Figure 3) a velocity gradient of 1.7±0.3 kms^{-1} kpc^{-1} growing increasingly negative in the direction of M31.

Figure 4: Velocity gradient across stars on the fields. The α and δ are the mean values of each field and are plotted with respect to the centre of field A27sf1, which lies between And XXVII and M31. Field 7And27 lies across the centre of And XXVII, while the remaining fields lie along NW-K1.



We obtain the spectroscopic [Fe/H] of the stars using the equivalent widths of the Calcium Triplet lines. Our results, see Figure 4, show no discernible difference between stars in And XXVII and those in NW-K1.

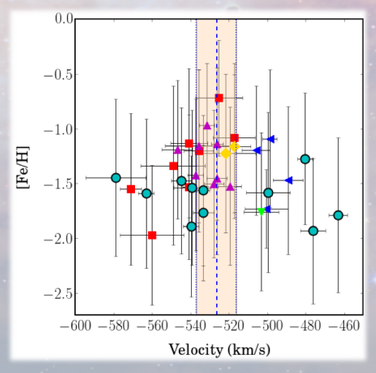


Figure 5: Metallicity vs stellar velocity for And XXVII/NW- K1 by field, where: red = A27sf1; magenta = 603HaS; cyan = 7And27; yellow = A27sf2; blue = A27sf3; green = 604HaS. The vertical, blue, dashed line indicates the systemic velocity of And XXVII. The shaded area, bounded by the blue dotted lines, indicates the uncertainties around this value

Key findings

- And XXVII: v = -526.1 ± 10 kms^{-1} ; σ_v = 27.0 ± 4.0 kms^{-1} and [Fe/H] = -2.1 ± 0.5.
- NW-K1: <v> = -519.4 ± 4.0 $kms^{-1;}$ <σ_v> = 10.0 ± 4.0 kms^{-1} and <[Fe/H]> = -1.8 ± 0.4.
- The velocity gradient is indicative of an infall trajectory towards M31

Conclusions

- The kinematic and spectroscopic properties of And XXVII and NW-K1 are consistent within 1-σ confidence limits, so it is likely that the two are associated.
- And XXVII is likely being tidally disrupted by M31, as evidenced by the unusually large value of σ_v for a dSph of this size.
- And XXVII is a plausible progenitor for NW-K1.
- The two sections of the NW stream are unlikely to be part of the same structure. Work by [4] finds an infall trajectory towards M31 in NW-K2. Given that both NW-K1 and NW-K2 lie behind M31, [5], it is unlikely that they are components of a single stellar structure around M31.

References

[1] Richardson et al. 2011: ApJ, 732:76
[2] McConnachie et al. 2018: ApJ , 868:55
[3] Dotter et al. 2008: ApJ, 178:89
[4] Veljanoski et al. 2013: ApJ, 768:L33
[5] Komiyama et al, 2018: ApJ, 853:29

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