Chemical characterisation of the ED-2 stream

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BACKGROUND:

Stellar streams form from the tidal stripping of globular clusters or dwarf galaxies. These streams cross the local stellar halo where the *Gaia* mission provides the full six-dimensional position and motion. Stars in a stream present small spreads in orbital properties e.g. energy and angular momenta. We can therefore search for steams as stars that cluster together in this space and then characterise their progenitor from their stellar populations.

METHODS:

- We applied a clustering algorithm to energy & angular momenta space of local halo stars from *Gaia* DR3.
- We find five new, dynamically tight and loosely bound clusters.
- The available chemical information was limited and so we obtained high-res UVES spectra for 20 stars, *(PI Dodd 111.D-0263A)* including 3 stars in the ED-2 stream. We supplemented this with archival spectra including for the Gaia BH3 companion star and 12 *Gaia* Sausage Enceladus stars.
- We derived homogenous abundances for 23 elements.

ED-2 is a disrupted ancient low mass star cluster, hosting the 33 $M_\odot$ black hole: *Gaia* BH3

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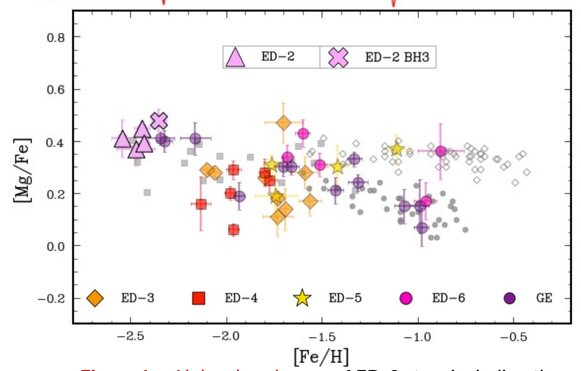

Figure 1 – Alpha abundances of ED-2 stars including the BH3 companion star. ED-2 stars are low metallicity with a small spread in [Fe/H] and in all other elements measured, see the paper for more elements. Gaia Enceladus and the rest of the ED streams shown here are also characterised in the paper. Grey points show halo stars from literature.

RESULTS:

- ED-2 stars are low metallicity with [Fe/H] ~ -2.5 dex and a very small spread in [Fe/H] and all other elements e.g. α, neutron capture → low mass cluster progenitor?
- No detected anti correlations in light element abundances but we need samples of > 5 stars to confirm this.
- ED-2 is very old, lower limit of ~13.8 Gyr (from comparison to M92)
- ED-2 contains the 33 $M_\odot$ BH near the Sun Gaia BH3. The red giant companion star is dynamically consistent and chemically consistent in all elements.
- Can constrain the formation channels of massive black holes (~30 $M_\odot$ peak seen with gravitational waves) either by single star evolution of a massive metal poor star or dynamical formation through mergers in a dense stellar cluster.

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