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High Precision Optical Follow-up of APOGEE-Identified Chemical Doppelgangers: Implications for Neutron-Capture Element Mixing in the ISM

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Recent work using APOGEE stellar abundances have suggested that the Milky Way disk is well-mixed and chemically simple, with age, [Fe/H], and [Mg/Fe] predicting a star's detailed chemical profile to high precision. APOGEE notably lacks access to strong lines of neutron-capture elements which may experience a distinct trajectory of chemical evolution that can not be traced by the aforementioned parameters. To test this, we obtain optical, R~60,000 spectroscopy of 27 APOGEE "chemical doppelgangers," random pairs of disk field giants that APOGEE indicates are as chemically similar as stars within open clusters, and investigate whether they are also "doppelgangers" in the neutron-capture elements. Selected doppelgangers are also required to have nearly identical stellar parameters and C/N ratios, a tracer of stellar age in giants. We perform line-by-line differential abundance analysis of doppelgangers' optical spectra and confirm that all are are indeed doppelgangers in the elements accessible by APOGEE with occasional exceptions of Al. We find that 20 of 27 pairs, however, are not doppelgangers in the neutron-capture elements. Additionally, we find apparent correlations between pairs' similarity in neutron-capture elemental abundances and their similarity in dynamical parameters. If we assume that stars in each doppelganger pair were born at relatively similar times and positions in the disk, then these results could point to a) azimuthal neutron-capture element variations in the interstellar medium that exceed those of the lighter elements, b) radial neutron-capture abundance gradients that are steeper than the gradients of lighter elements, and/or c) random neutron capture abundance variations in the radial direction that act independently of the lighter elements. These results emphasize the value of neutron-capture elements in identifying stars with similar chemical compositions and Galactic origins.

Author: MANEA, Catherine (Columbia University)

Co-authors: Prof. HAWKINS, Keith (The University of Texas at Austin); Prof. NESS, Melissa (The Australian National University)

Presenter: MANEA, Catherine (Columbia University)