# THE CHEMICAL AND DYNAMICAL EVOLUTION OF THE GALACTIC DISK

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ABSTRACT. For a sample of 189 disk stars, essentially dwarfs of spectral type F, we have determined chemical abundances of O, Na, Al, Mg, Si, Ca, Ti, Fe, Ni, Y, Zr and Ba, as well as ages and space motions. These stars have deep enough convection zones so that the surface layers may be presumed to be well mixed and thus representative of the chemical composition of the pre-stellar cloud. The sample was selected without kinematical bias such that the stars represent different metallicity groups ranging from [Fe/H]=-1.0 to 0.3 and such that ages, varying from 1 to 15 Gyears, can be derived from isochrones. Thus, the chemical composition of the interstellar medium, as a function of age and galactocentric distance (approximated by R(m) = 0.5*{R(apogal)+R(perigal)}) may be mapped. The following basic results are obtained:

1. The alpha-element (O, Mg, Si, Ca, Ti) abundances vary relative to Fe in a well defined way as a function of [Fe/H] with an excess of [alpha/Fe] for the more metal-poor stars.The excess is significantly greater for O than for the other alpha elements, which is not expected from recent SN II model calculations. There is, for the most metal-poor stars, a tendency for the alpha excess to decrease as a function of R(m).This probably indicates a more rapid star formation in the interior parts of the early Galactic disk. The individual scatter around these relations is about 0.05 dex, as expected from the observational errors, indicating an efficient mixing of gas enriched by alpha elements and Fe, respectively, in the disk at all times.



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2. The abundances of the "odd" elements Na and Al, relative to Fe, show a less pronounced variation with [Fe/H], Al yet being more similar to the alpha elements in this respect.This puts further constraints on supernova models.

3. The Fe abundance relative to H shows a general tendency to decrease with increasing age. The scatter around this relation (0.2 dex) is, however, significantly greater than the expected observational differential uncertainty in [Fe/H] and is also hard to explain as a a result of bias in the selection procedure or of orbital diffusion, and even as a combination of these. This suggests that mixing of metal-rich and metal-poor gas in the Galaxy is significantly less efficient than that of SN II (alpha-rich) and SN Ia (Fe-rich) gas. This might be explained as a result of infall of metal-poor gas; however, a very efficient triggering of star-formation by this infall is then necessary if current estimates of the infall rate are typical for the history of the Galactic disk. Alternatively, one has to invoke identical or similar sites for the production of alpha elements and Fe, yet giving relative contributions of these elements that vary as a function of Galactic age. The scatter in [Fe/H] at a given age and R(m) could then be explained as the result of star formation occuring both in well mixed interstellar gas and in gas enriched by local supernovae. Another, more speculative explanation would be that the Galactic disk is the result of the merging of two different galaxy populations.

4. The abundances of Ba and other s-elements relative to Fe show a significant variation with age at a given [Fe/H], indicating a long characteristic time scale for the formation of these elements, yet different from that of the formation of Fe.

5. The three most s-element rich stars were found to have very similar R(m). We suggest an s-element rich gas cloud to be the common origin of these.

6. There is a significant tendency for some additional grouping in the dynamic-chemical space for our sample of field stars. We tentatively suggest a group of less than 10 sample stars to which the Sun belongs to be enriched in Ca and Fe, relative to other elements like Na, Mg, Al and Si, as compared with other stars of solar overall metallicity.

The details of this study will be published in forthcoming papers in Astronomy & Astrophysics.

G. Hensler: Do your results concerning the metal content of the old disk stars with respect to their radial positions allow the conclusion that a radial propagation of metal enrichment must have happened during disk formation?

B. Gustafsson: I think our variation of the alpha-element abundance relative to iron, at a given iron abundance, as a function of galactocentric mean distance, may indicate a radial propagation of the alpha-element enrichment.