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This Week's Citation Classic®

Goldberg L, Müller E A & Aller L H. The abundances of the elements in the solar atmosphere. (Whole issue.) *Astrophys. J. Suppl. Ser.* 5(Suppl. 45), 1960. 138 p.
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The method of weighting functions has been used to derive the abundances of 42 of the 60 elements with atomic lines in the region of the solar spectrum accessible from the surface of the earth. Major sources of uncertainty in the derivation of abundances are discussed in detail. [The *SCI*® indicates that this paper has been cited in over 325 publications.]

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I first became interested in the problem of chemical abundances in the sun in 1933, as a senior undergraduate at Harvard. D.H. Menzel suggested that I undertake to calculate the relative strengths of multiplets in a transition array as a preliminary to improving H.N. Russell's[1] pioneering determination of solar abundances. Laboratory measurements of spectral line intensities were then nonexistent. The publication in 1934 of C.W. Allen's[2] extensive tables of equivalent widths made the time ripe for a new investigation of abundances. Soon thereafter, the entry of the US into World War II interrupted the abundance project, and it was terminated shortly after the war ended, when A. Unsold,[3] in Germany, published the results of an almost identical investigation.

In 1952 G.P. Kuiper invited me to a conference at Yerkes Observatory, which was attended by Harrison Brown, George Gamow, Harold Urey, and others concerned with the crucial role played by accurate solar abundances in testing theories of stellar evolution and the origin of the solar system. Kuiper later invited me to prepare a critical review of published solar abundance determinations for volume four of a four-volume compendium of the solar system, which he was organizing and editing. I readily agreed and asked my colleagues, L.H. Aller and E.A. Müller, to be coauthors. It soon became apparent that, instead of a review, we needed a completely new determination of abundances based on modern theory and new solar and laboratory data.

The paper was widely cited because it was published at a time when astronomers were testing the validity of theories of stellar evolution and element-building in stars, with particular reference to differences in abundance between stars of Baade's populations I and II and anomalous abundances in the carbon stars and in certain A-type stars. Investigators minimized errors by determining stellar abundances relative to those in the sun, using the results of the paper as standard. Since 1960, values of element abundances in the sun have been extended and improved by the availability of new data on laboratory line strengths.[4] For recent work in this field, see reference 5.

1. **Russell H N.** On the composition of the sun's atmosphere. *Astrophysical J.* 70:11-82, 1929.
2. **Allen C W.** The intensity of Fraunhofer lines in the region 4036-6600 A. (Whole issue.) *Mem. Commonw. Solar Observ. Canberra* 1(5, Pt. 1), 1934. 57 p.
3. **Unsold A.** Quantitative Spektralanalyse der Sonnenatmosphare. *Z. Astrophys.* 24:306-29, 1948.
4. **Withbroe G L.** The chemical composition of the photosphere and corona. (Gebbie K B, ed.) *Proceedings of the Menzel Symposium on Solar Physics. Atomic Spectra, and Gaseous Nebulae. Harvard College Observatory. 1971.* Washington, DC: National Bureau of Standards, 1971. p. 127-48.
5. **Aller L H.** Chemical abundances in the stars and nebulae. (Dalgarno A & Layzer D, eds.) *Spectroscopy of astrophysical plasmas.* Cambridge, England: Cambridge University Press, 1986.

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