

S-Process Deficiencies in Low-Mass Supergiant Variables

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We have carried out abundance analyses of four low-mass supergiant variable stars (the RV Tauri or RV Tau-like variables AI Cmi, RU Cen, and U Mon, and the Type II Cepheid Kappa Pav) and two Population I Cepheids (OO Aur and V378 Cen). We used model atmospheres in which hydrostatic equilibrium, plane-parallel geometry, and local thermodynamic equilibrium (LTE) were assumed. Discussion of the results, and of published analyses of additional low-mass variables, leads to the following conclusions. (1) The Population I Cepheids show normal, solar elemental abundance ratios (except for the CNO elements, which have been altered by hydrogen burning), lending some support to the validity of the above assumptions for analyses of luminous variable stars. (2) The low-mass variables show metallicities ranging from solar down to $[Fe/H]$ values typical of thick-disk and, in a few cases, of halo stars. (3) Most low-mass variables show a systematic underabundance of the heavy s- and r-process elements. In a few cases this may indicate that the stars were initially of extremely low metal content, and are now hydrogen deficient. However, most of the variables do not appear to belong to the halo population, nor do they show other abundance patterns seen in halo stars. The origin of these underabundances, and their apparent confinement to luminous variables, are difficult to understand in the context of nuclear processing. (4) The heavy-element underabundances correlate with second ionization potential in a manner suggesting that they are non-LTE phenomenon arising from overionization by Lyman-continuum photons. Why a similar effect is not seen in Population I Cepheids is unclear, but may be related to their generally weaker hydrogen emission. (5) Several low-mass variables, including RU Cen and V553 Cen, show carbon enhancements and solar s-process abundances. Relative to the majority of the Type II variables, these stars are s-process enhanced, and we argue that they are related to the Ba II and CH stars.