Are the Barium and Am Stars Related?

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A study of barium star kinematics from 112 stars with known radial velocities indicates a solar motion of

$u_\odot$(km/s)	$v'_\odot$(km/s)	$w_\odot$(km/s)	$S_\odot$(km/s)
-15.6	16.3	10.5	24.9

All values have errors of roughly ±2.6 km/s.

Parameters of the velocity ellipsoid from 32 barium stars with independently-determined absolute magnitudes are.

$\langle u^2 \rangle^{1/2}$(km/s)	$\langle v^2 \rangle^{1/2}$(km/s)	$\langle w^2 \rangle^{1/2}$(km/s)
24	16	15

These values, a scale height of barium stars perpendicular to the galactic plane of 230 pc (Lü 1988, private communication), and an estimate of the spatial distribution of stars in the Galactic plane all indicate that barium stars belong to an intermediate disk population with masses between 1.5 and 3.0 solar masses and ages of 5×10^8 to 2×10^9 years.

Given the masses of barium stars and their tendency for binaricity, one is tempted to look for likely progenitors. One class of binary main-sequence star in this mass range is the Am (or metallic-lined A) star.

Mass transfer in a binary system is often thought to lead to the formation of a barium star, and excess s-process elements are conveniently present in Am atmospheres (probably due to diffusion resulting from tidal braking and subsequent slow rotation). Am stars have closer orbital separations and larger mass ratios than barium stars, which provide reasonable constraints to any mass transfer/loss model of barium star formation. This relationship between stellar types could explain why barium stars exhibit (1) peculiar atmospheric abundances of heavy elements with no sign of recent s-process production, and (2) white dwarf companions. Numerically, Am stars are roughly ten times more common than barium stars, indicating that such an evolutionary relationship is reasonable. Mass transfer/loss also introduces a random element which might explain statistical barium star peculiarities such as their huge range of absolute magnitudes.

A few evolutionary models are presented, even though the combination of diffusion, mass transfer, and normal stellar evolution make such models far from unique.