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A Variation on the Baade-Wesselink Technique

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Consider a radially pulsating star. Expand the radius variation in a Fourier series: $R = R_0 + A_1 \cos(\omega t + \phi_1)$ [summation convention]. The velocity is $v = -i\omega A_1 \sin(\omega t + \phi_1)$. The ratio of the radii at two phases of the cycle may be written

$$(R_1/R_2)^2 = (L_1 T_2^4)/(L_2 T_1^4) \equiv \alpha. \quad (1)$$

Setting $R = R_0 + \Delta r$ ($\Delta r/R_0 \ll 1$), we obtain $R_0 = 2(\alpha \Delta r_2 - \Delta r_1)/(1-\alpha)$. The radial excursion Δr at any phase of the pulsation may be determined from a Fourier fit to the observed velocity curve. Assuming highly accurate velocity data (e.g. CORAVEL data), this can be done very precisely. If we choose phase 2 to be that for which $\Delta r_2 = 0$, we have

$$\alpha = (2/R_0)\Delta r_1 + 1. \quad (2)$$

Obtaining energy scans at various values of Δr_1 , we may use model atmospheres to determine the function $\alpha(\Delta r_1)$ from Eq. (1). Then, the slope yields R_0 via Eq. (2). Since the zero point is constrained [$\alpha(0) = 1$], we have a check on our determination of α from the energy scans. Another check comes from choosing Δr_2 in a different way - namely, to correspond to the maximum positive displacement. In that case, α must attain its minimum value at the minimum of Δr_1 . We discuss the use of these variations to determine the radius R_0 and to test the application of model atmospheres to pulsating stars.