RELAXATION OF MASS-GAINING STARS

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The study of relaxing low-mass stars, after gaining mass, to their corresponding main-sequence counterparts is presented. An initial mass of the star was 0.56 $M_\odot$ which was gaining mass at a rate increasing gradually from about 10^{-10} to about 10^{-8} $M_\odot y^{-1}$. The initial chemical composition used for computation was: 75% H, 22.3% He, and 2.7% heavy elements. The mass-gaining stellar model is assumed to be spherically symmetric and in hydrostatic and thermal equilibrium; also it is assumed that mass is absorbed through the stellar envelope from a uniformly distributed outer shell. A sequence of static models was calculated with time steps between the models chosen in such a way as to maintain the changes in physical variables with certain limits from one model to the next. This series of mass-gaining calculations was carried out to the model of 0.835 $M_\odot$. Another series of calculations was carried out in order to investigate the effects of stopping the mass transfer and allowing the star to relax. Each of the twelve selected mass-gaining models was used as the starting point for one of these relaxation sequences; and for each of these twelve masses, a zero-age main sequence model was calculated. The relaxation models were calculated from the same evolutionary technique except that the mass-transfer rate was set to zero. The criterion for stopping these relaxation runs was that the gravitational luminosity term in the envelope should have returned to the main sequence value. An interesting result of these calculations is the finding that in this region of the main sequence where stars have radiative cores, mass-gaining stars develop convective cores. In this particular model sequence, the convective instability first became evident in the model of 0.7125 $M_\odot$ with the logorithm of the central temperature of 7.047. The result of the relaxation calculations shows that, in each case, the star did relax to its corresponding main sequence position. In general, the relaxation process compares favorably with the thermal time scale for these stars. For the model of 0.745 $M_\odot$ at the time when the luminosity increases, indicating that the effective source is reaching the surface, the convective core begins to disappear. The star then decreases its surface temperature, moving to the right in the H-R diagram, while the convective core disappears completely. The H-R diagram track then turns upward toward its proper main sequence location while the contral density and temperature and the luminosity due to nuclear energy generation decrease to their normal values. During this time, the radius and the total luminosity increase to their normal main sequence values.

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