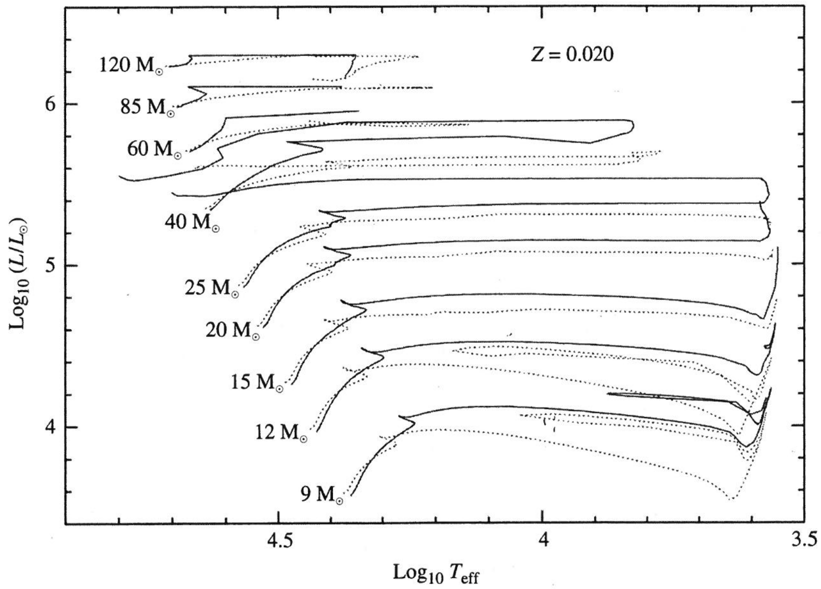

FIGURE 15.3 The evolution of massive stars with $Z = 0.02$. The solid lines are evolutionary tracks computed with initial rotation velocities of 300 km s^{-1}, and the dotted lines are evolutionary tracks for stars without rotation. Mass loss has been included in the models and significantly impacts the evolution of these stars. (Figure from Meynet and Maeder, *Astron. Astrophys.*, *404*, 975, 2003.)

ranging in mass from 9 M$_\odot$ to 120 M$_\odot$ are shown in Fig. 15.3. These models of Georges Meynet and Andrés Maeder include mass loss typical of massive stars. The models are also computed with and without rotation; when rotation is included, the equatorial rotation speed is taken to be 300 km s^{-1}. Meynet and Maeder point out that rotation can have an appreciable affect on stellar evolution, including driving internal mixing and enhancing mass loss.

The Humphreys–Davidson Luminosity Limit

These massive-star evolutionary tracks indicate that the most massive stars never evolve to the red supergiant portion of the H–R diagram. This is in agreement with the qualitative evolutionary scenario presented above, and it is also consistent with observations. Humphreys and Davidson were the first to point out that there is an upper-luminosity cut-off in the H–R diagram that includes a diagonal component running from highest luminosities and effective temperatures to lower values in both parameters. At that point, when full redward evolutionary tracks develop for stars below about 40 M$_\odot$, the **Humphreys–Davidson luminosity limit** continues at constant luminosity.

Although very massive stars are extremely rare (only one 100 M$_\odot$ star exists for every one million 1 M$_\odot$ stars), they play a major role in the dynamics and chemical evolution of the interstellar medium. The tremendous amount of kinetic energy deposited in the ISM through the stellar winds of massive stars has a significant impact on the kinematics of the ISM. In fact, when very massive stars form, they have the ability to quench star formation