ON ALUMINUM-26 IN MASS LOSS FROM MASSIVE STARS. B. S. Meyer[1], L. S. The[1], and M. F. El Eid[2], [1]Department of Physics and Astronomy, Clemson University, Clemson, SC 29634-0978, USA, [2]Department of Physics, American University of Beirut, Beirut, Lebanon.

Introduction: It has been proposed that the live ^{26}Al present in the early Solar System was injected by winds from a massive star (e.g, [1,2]). Aluminum-26 is produced in the hydrogen shell during the massive stars presupernova evolution. When convection reaches down into this shell, it draws up material that can then be ejected in the stellar wind. In this abstract, we study the mass loss from two initially 25 solar mass stellar models and their ^{26}Al content to help clarify when injection of material into the Solar cloud by stellar winds can occur.

The Stellar Models: To compute the stellar models, we used the Clemson/AUB stellar evolution code [3]. The models used initially solar compositions and were identical except in their treatment of convection. The first model used the Schwarzchild criterion for convection while the second used the Ledoux criterion together with semiconvective mixing. Mass loss was included in both models according to the prescription of [4].

Mass Loss: Fig. 1 shows the cumulative mass lost from the star as a function of time before the stellar explosion. Both models lose about one solar mass of material in the first six million years of their lives. About 600,000 years before the explosion, when core hydrogen burning has finished and the models evolve to the red-giant branch (RGB), however, mass loss increases rapidly. By 100,000 years before the explosion, most of the mass loss has occurred in both models.

It is clear that the model with Ledoux convection plus semiconvection loses considerably more mass and does so more rapidly. The Ledoux criterion restricts convection relative to the Schwarzchild criterion, particularly in the zones above the hydrogen shell. This, in turn, limits the strength of the hydrogen shell and causes the star to proceed directly to the RGB. In contrast, the model using the Schwarzchild criterion has a stronger hydrogen burning shell and evolves to the RGB more gradually. For a review of these ideas, please see [5,6].

Aluminum-26 in the Wind: Fig. 2 shows the surface ^{26}Al mass fraction as a function of time prior to the stellar explosion. Since the wind is lost from the stellar surface, this figure also shows the instantaneous ^{26}Al mass fraction in the wind as a function of time. The early mass loss from the models contains no ^{26}Al because hydrogen shell burning has not yet occurred, and, once it has, convection has not reached down into ^{26}Al-rich material.

As discussed above, the relative weakness of the hydrogen shell in the Ledoux criterion model causes it to evolve rapidly to the RGB and to have convection reach immediately into the ^{26}Al-rich material. For this reason, the wind almost always contains ^{26}Al. In contrast, the strong hydrogen shell for the Schwarzchild criterion model leads to more gradual mass loss and growth of the convective envelope. In this model the wind contains abundant ^{26}Al in the last ~150,000 years of the star's life.

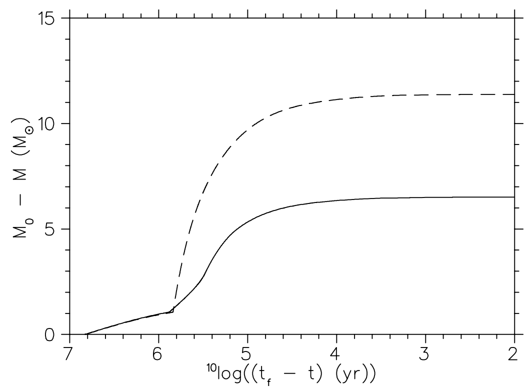

Fig. 1. Cumulative mass lost from the initially 25 solar mass stellar models as a function of time prior to the star's explosion. The solid curve is for the model with Schwarzchild convection while the dashed curve is for the model with the Ledoux criterion plus semiconvection.

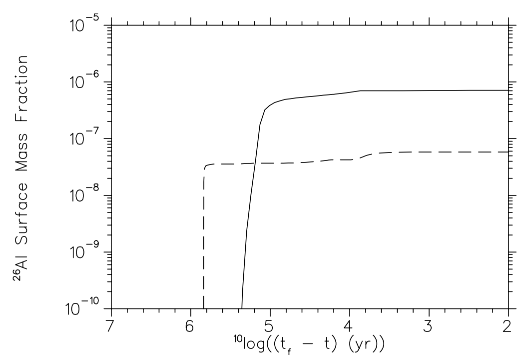

Fig. 2. Surface ^{26}Al mass fraction as a function of time in the initially 25 solar mass stellar models. The solid and dashed curves have the same meaning as in Fig. 1.

Conclusions: In the initially 25 solar mass models we present here, the mass loss relevant for the injection of ^{26}Al into the Solar cloud occurs in the last ~600,000 years of the star's life. The models also show that the strength of the mass loss and the ^{26}Al content in the winds leaving the star depends sensitively on the treatment of convective mixing. The Ledoux criterion plus semiconvection model has a weak hydrogen burning shell. This model evolves rapidly to the RGB and blows a ^{26}Al-rich wind soon after the star completes core hydrogen burning. The star using the Schwarzchild criterion for convection has a strong hydrogen burning shell. Mass loss is weaker and more gradual, and the wind is not rich in ^{26}Al until the last ~150,000 years of the star's life.

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