# THE CREATION OF LITHIUM IN GIANT STARS

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A time-dependent "*convective diffusion*" algorithm for convective transport in the mixing-length framework has been coupled for the first time with a *self-consistent* full evolutionary computation, in order to investigate theoretically the creation of superrich lithium stars on the asymptotic giant branch. For intermediate mass stars in the mass range from 4 to 7 $M_\odot$ with both Population I and II compositions, *hot bottom burning* in the convective envelope was found, with maximum temperatures $T_{ce}$ at the base of the convective envelope ranging from 20 to 100 million K, depending on stellar mass and mass loss rates. For $T_{ce} \geq 40$ million K, *lithium-rich giants* were produced (with $\log \varepsilon(^7\mathrm{Li}) \gtrsim 1$, i.e., *above* the *normal* observed range in giants). For $T_{ce} \geq 50$ million K, *superrich lithium giants* were created, with $\log \varepsilon(^7\mathrm{Li}) \gtrsim 3$ (i.e., *larger* than the present *cosmic* $^7$Li abundance). *Superrich lithium giants* were created for stars in the *approximate mass range from* 4 *to* 7 $M_\odot$ *for both Population I and II*. Peak $^7$Li abundances were found to lie in the range $4 \lesssim \log \varepsilon(^7\mathrm{Li}) \lesssim 4.6$, relatively *independent* of mass and chemical composition. We predict a *narrow luminosity range* for superrich lithium stars, namely $-6 \gtrsim M_{\mathrm{bol}} \gtrsim -7.2$, i.e., $4.3 \lesssim \log L \lesssim 4.8$. Both the predicted peak $^7$Li abundances and the predicted luminosity range are in beautiful agreement with the observed values for the Galaxy and the Magellanic Clouds. High $^7$Li abundances persist for $10^4$ to $10^5$ years. *Mass loss* in AGB stars *can strongly affect* the $^7$Li production; it affects the *peak* $^7$Li *abundance* produced and the *mass of lithium-rich material ejected* into interstellar space, as well as the *timescale and luminosity range* over which



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the *superrich lithium phenomenon* is observable. For a *modest* mass loss rate (a Reimers' wind with $\eta = 1.4$), superrich lithium stars are produced from 4 to 7 $M_\odot$. For a more *realistic* intermediate mass loss rate ($\eta = 5$), the 4 $M_\odot$ star was *prevented* from becoming a *superrich lithium star* — it *never even became lithium rich*; for 5 through 7 $M_\odot$, the *peak* $^7$Li *abundance* is *unaffected* by the increased mass loss, but the *mass of lithium-rich material ejected* into space is *greatly increased*, and thus the total mass of lithium ejected from these stars increases by a factor of 3 over our modest mass loss case. For an *extreme* mass loss rate ($\eta = 14$), even the 5 $M_\odot$ star *barely* reaches superrich lithium abundances ($\log \varepsilon(^7\mathrm{Li}) \approx 3$), ejecting only *minor amounts of lithium*; on the other hand, the *peak* $^7$Li *abundance* in 6 and 7 $M_\odot$ stars is *unaffected*, and the amount of lithium ejected by these stars is again increased, by a factor of 3 over the intermediate mass loss case. We conclude that *intermediate mass AGB stars* are *major sources of cosmic lithium*, able to account for $0.5^{-0.25}_{+0.5}$ of the cosmic abundance with our most realistic mass loss rate ($\eta = 5$). With the extreme mass loss case ($\eta = 14$), AGB stars can also provide $0.5^{-0.25}_{+0.5}$ of the cosmic lithium, while the modest mass loss rate ($\eta = 1.4$) can provide $0.2^{-0.1}_{+0.2}$ of the cosmic lithium.