The LiBeB Data $[Fe/H] \equiv \log(Fe/H) - \log(Fe/H)_{\odot}$

Li plateau (Spite) – Big Bang Nucleosynthesis; possible ^{6}Li plateau

Linear Be evolution $\rightarrow$ Be/Fe $\approx$ constant

B/Be $\approx$ constant; $^{11}B/^{10}B = 4.05 \pm 0.2$(meteorites); 3.4 ± 0.7(ISM)

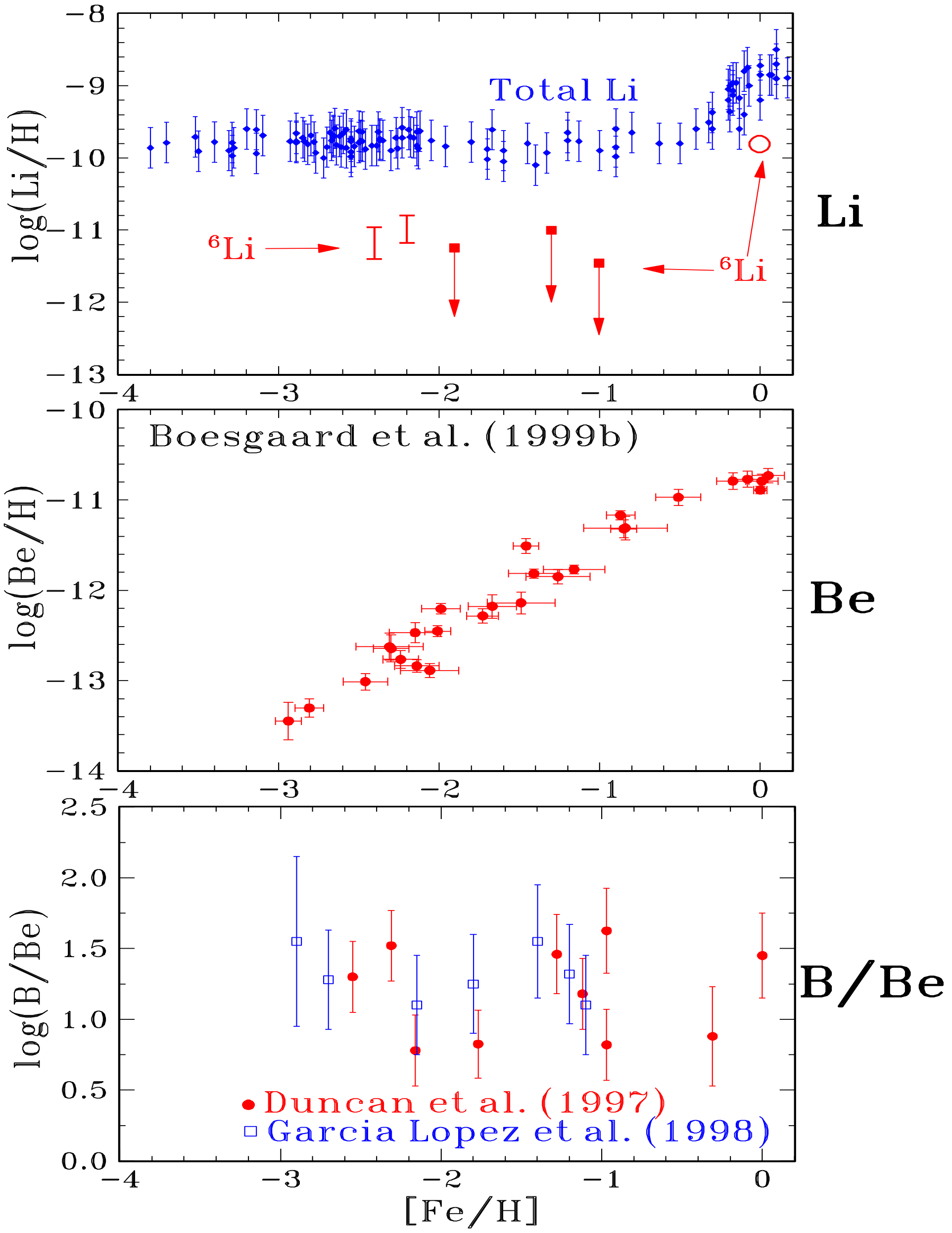


FIGURE 1.

O/Fe abundance ratio observations; the reported abundances diverge at low [Fe/H]

Fields and Olive (1999) claimed that high [O/Fe] at low [Fe/H] revive the previously demonstrated untenable CRI model

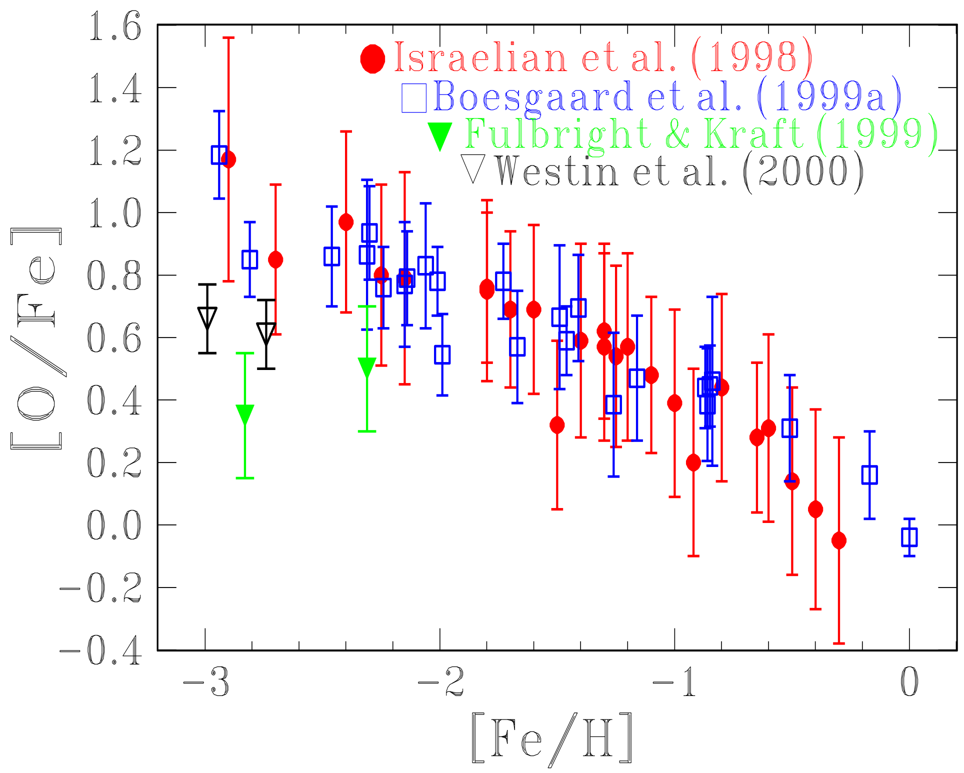


FIGURE 2.

Ejected masses of O and Fe from core collapse SNe

WW95 – minimum Ni-Fe yield models of Woosley & Weaver (1995)

TS98 – Tsujimoto & Shigeyama (1998), based in part on data of current epoch SNe

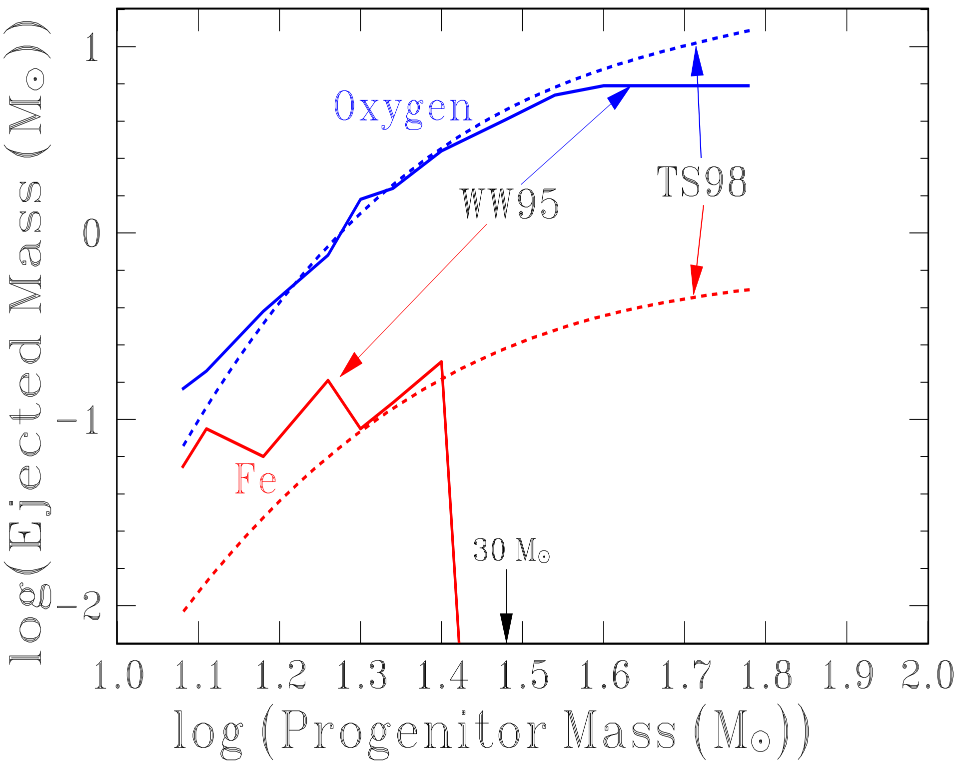


FIGURE 3.

O/Fe Evolution

WW95 with delays – maximum O/Fe

TS without delays – minimum O/Fe

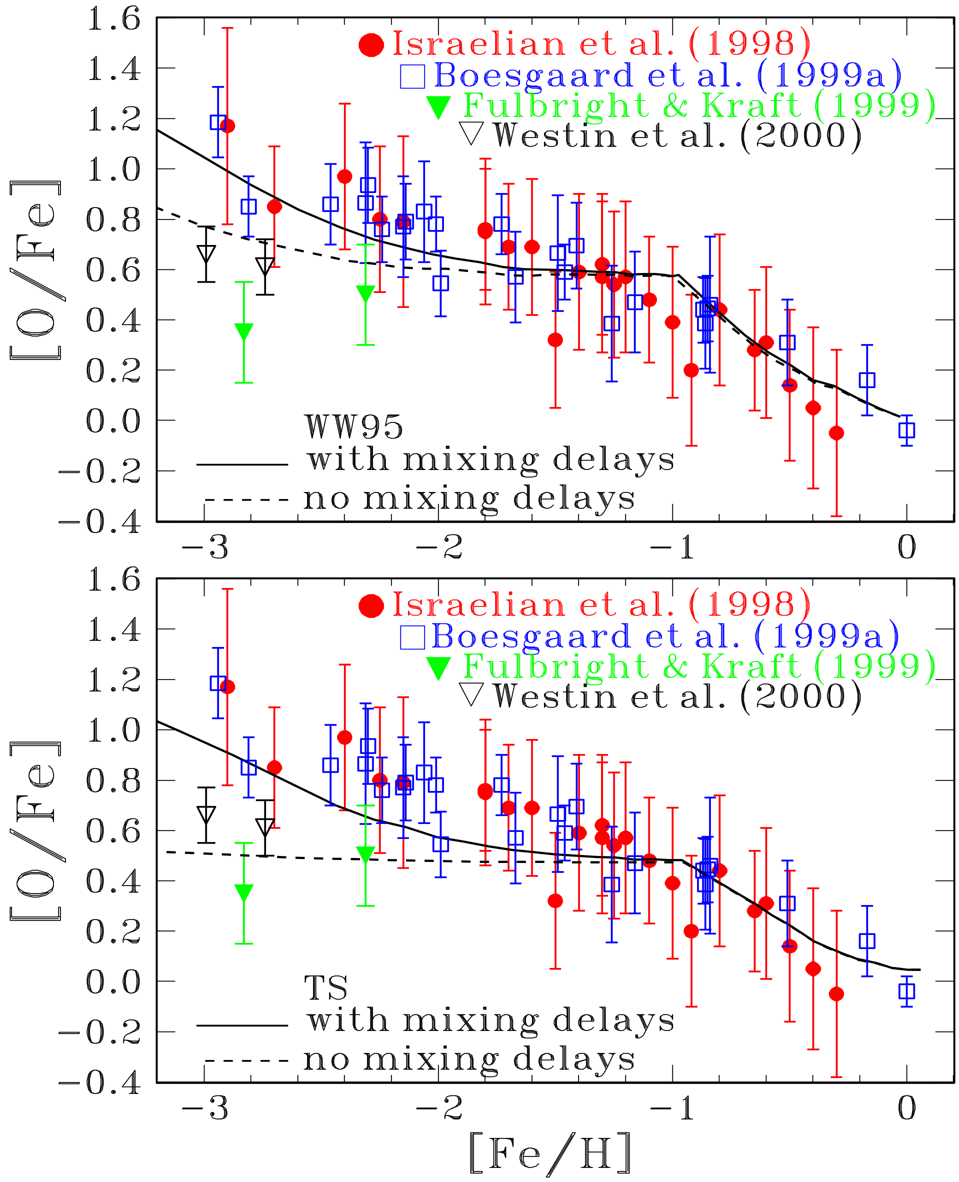


FIGURE 4.

ISM and Cosmic Ray Source Evolution

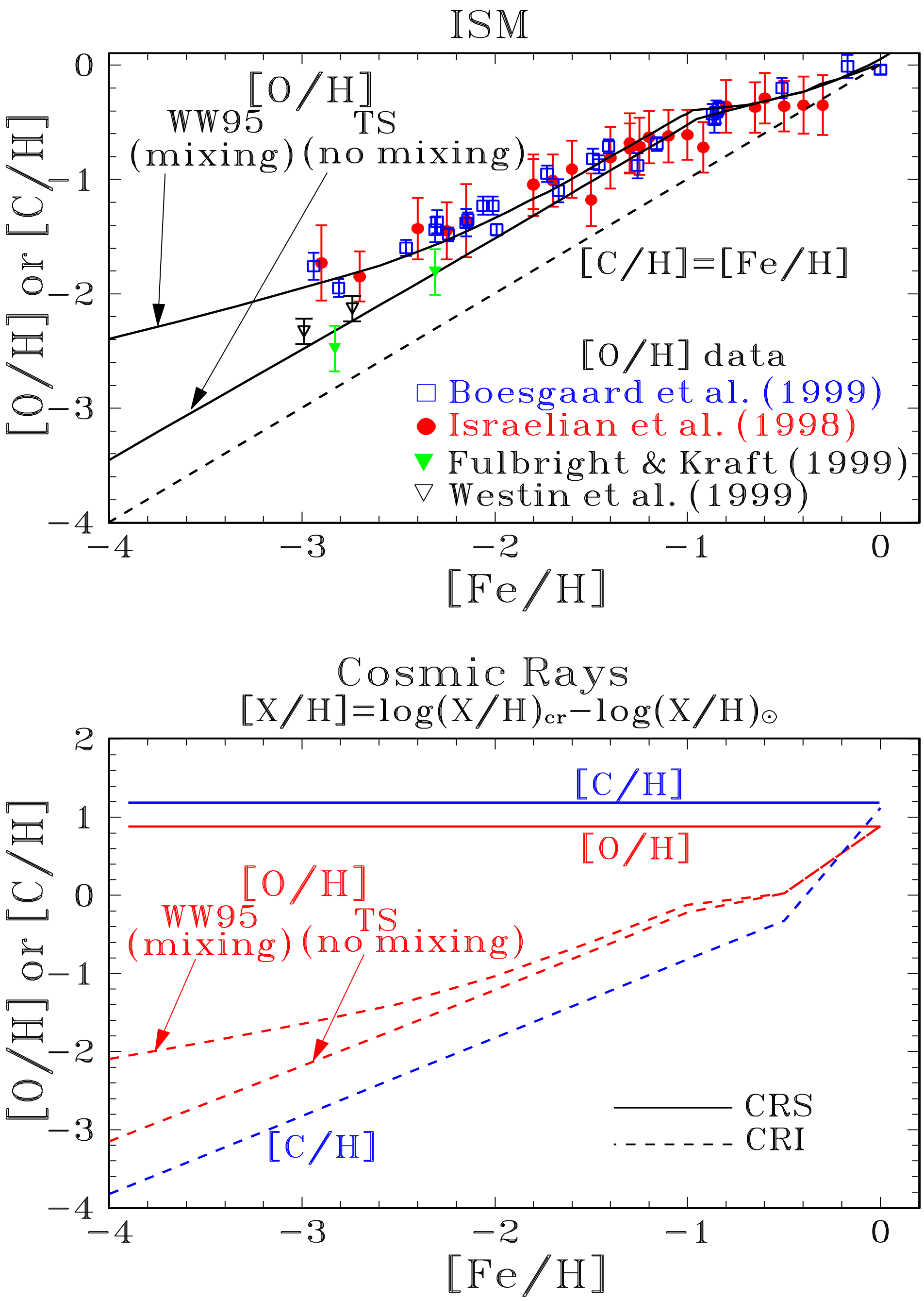


FIGURE 5.

Q/W (atoms/erg) – energy in cosmic rays from a given source to produce 1 atom of LiBeB

ISM and CR source compositions as functions of [Fe/H]

CR source energy spectrum $Q_{cr}(E) \sim (p^{-s}/\beta)e^{-E/E_0}$ – shock acc.

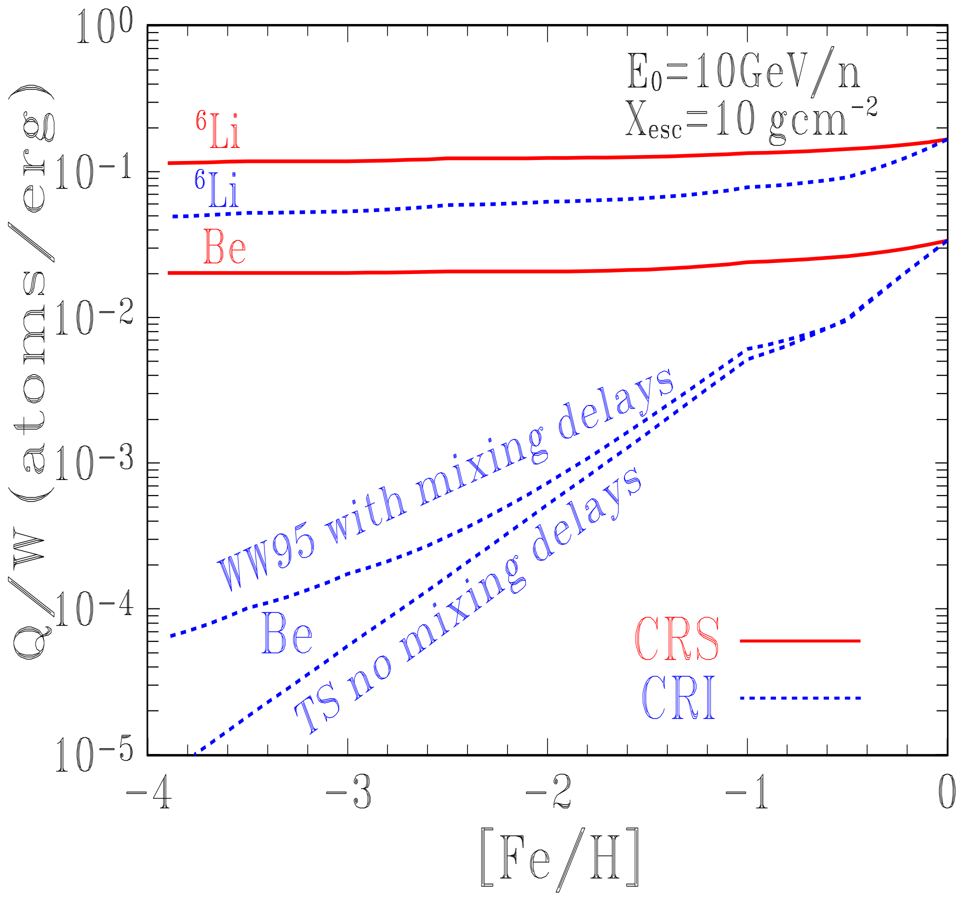


FIGURE 6.

Be/H evolution as a function of both Fe/H and O/H

n_H, the density of the ambient medium, determines the delay of the Be deposition due to cosmic ray transport

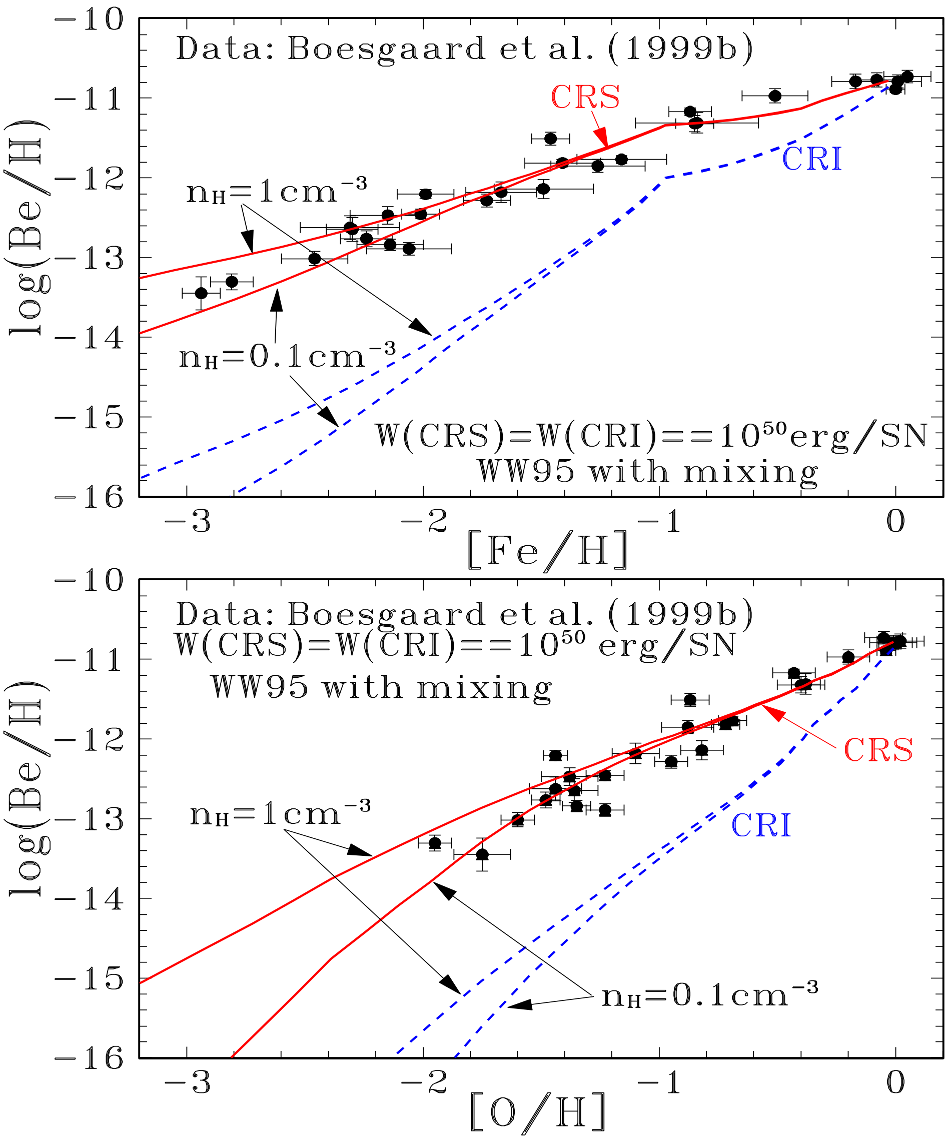
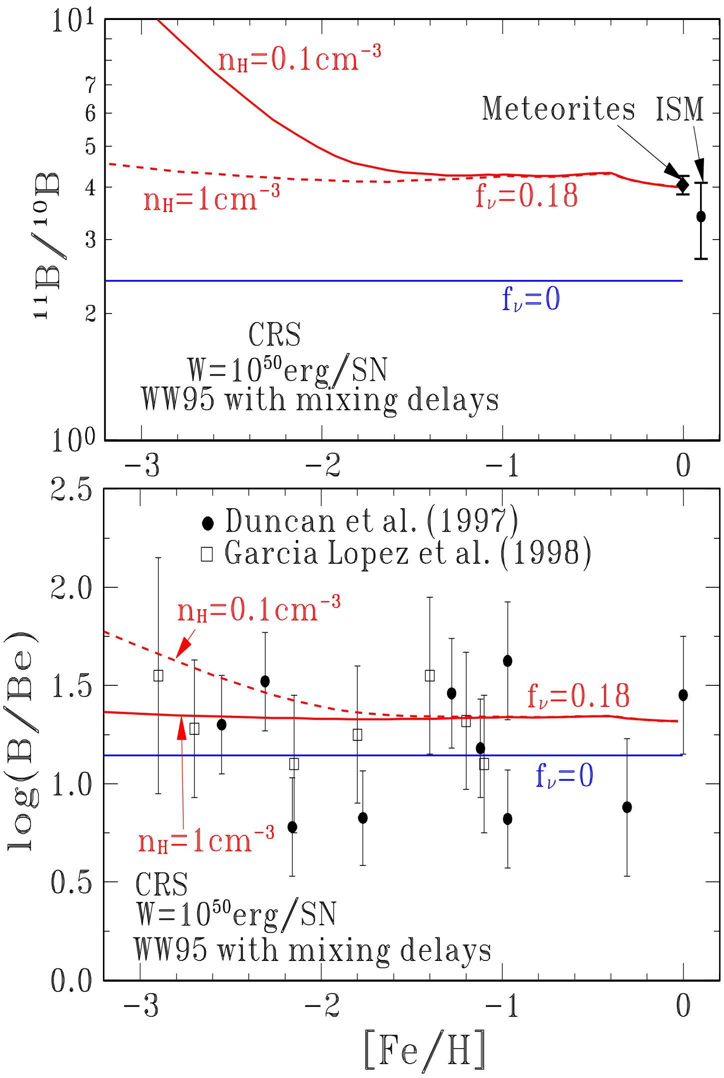


FIGURE 7.

$^{11}B/^{10}B$ and B/Be evolution

The rise for $n_H = 0.1$ is due to the delayed deposition of the cosmic-ray produced Be and B relative to the ν-produced ^{11}B for which we took a short delay time, the same as for O (1 Myr).



^{11}B production by neutrino spallation of carbon in core collapse SNe added

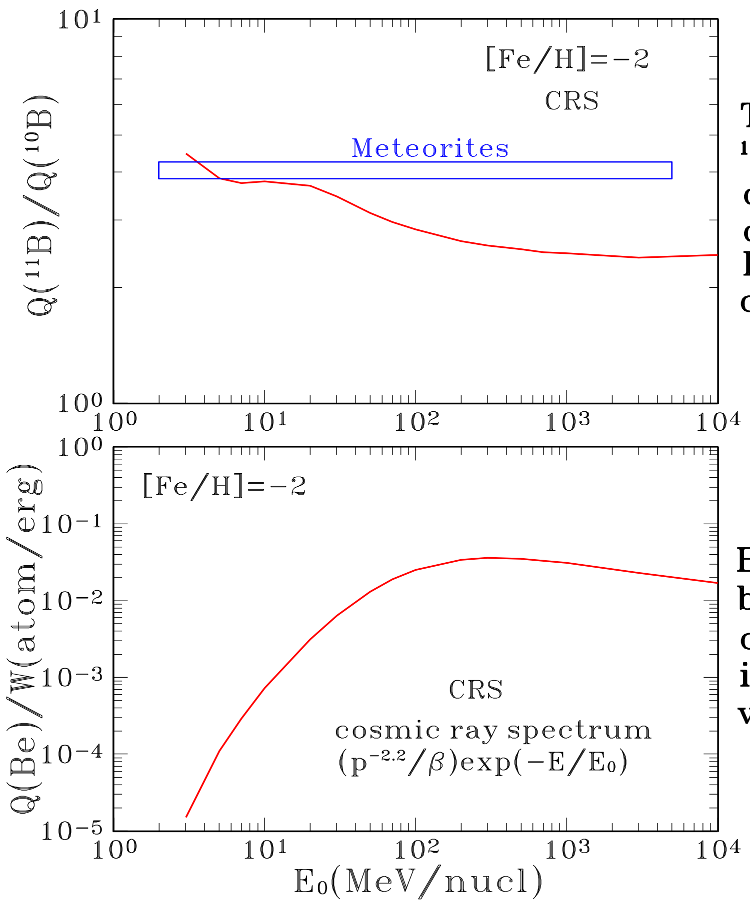
f_ν is the fraction of the nominal WW95 yields used

FIGURE 8.

LECRs as an alternative to extra ^{11}B production by SNII neutrinos?

LECR spectrum $\frac{p^{-2.2}}{\beta} e^{-E/E_0}$

Very low energy LECRs needed – inefficient energetics



The meteoritic ^{11}B/^{10}B ratio can be achieved only with very low energy cosmic rays

Be production by such cosmic rays is energetically very inefficient

FIGURE 9.

Be/H evolution as a function of both Fe/H and O/H in the hybrid CRI+LECR model

50% more energy per SN is imparted to the LECRs than to the CRI or CRS cosmic rays; E_0(LECR)=30MeV/n

LECRs are accelerated only by SNII; the Be at low [Fe/H] is almost totally from the LECR, but at [Fe/H]=0 CRI dominates

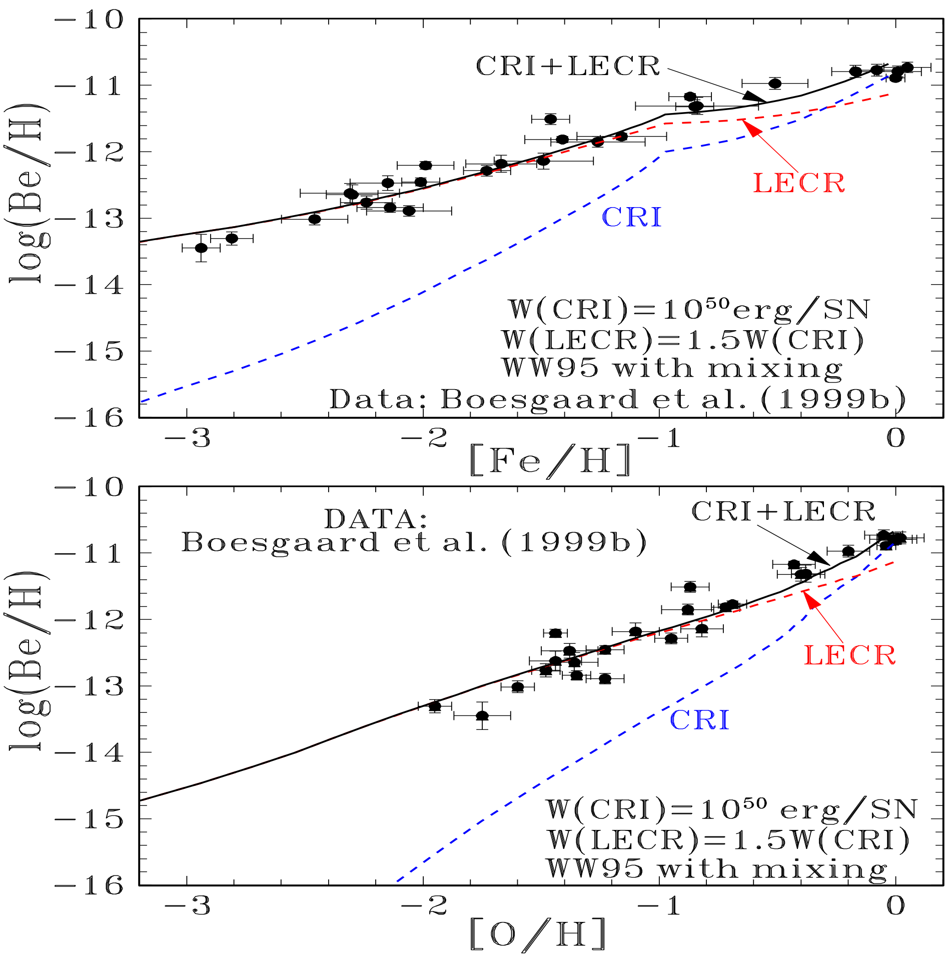
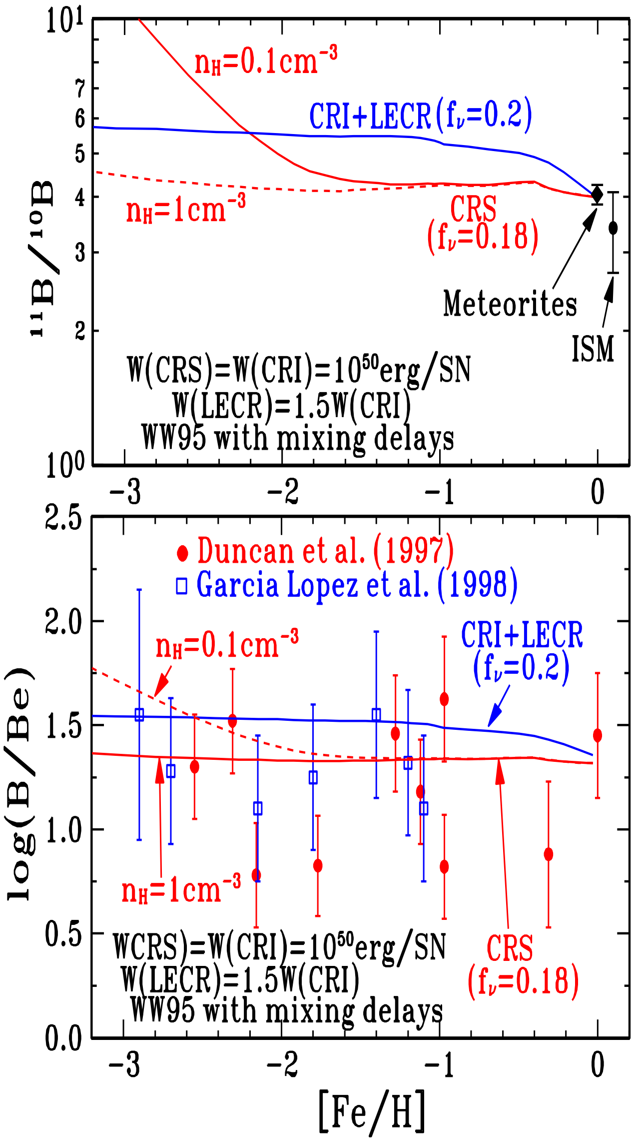


FIGURE 10.

$^{11}B/^{10}B$ and B/Be evolution in the CRS and CRI+LECR models



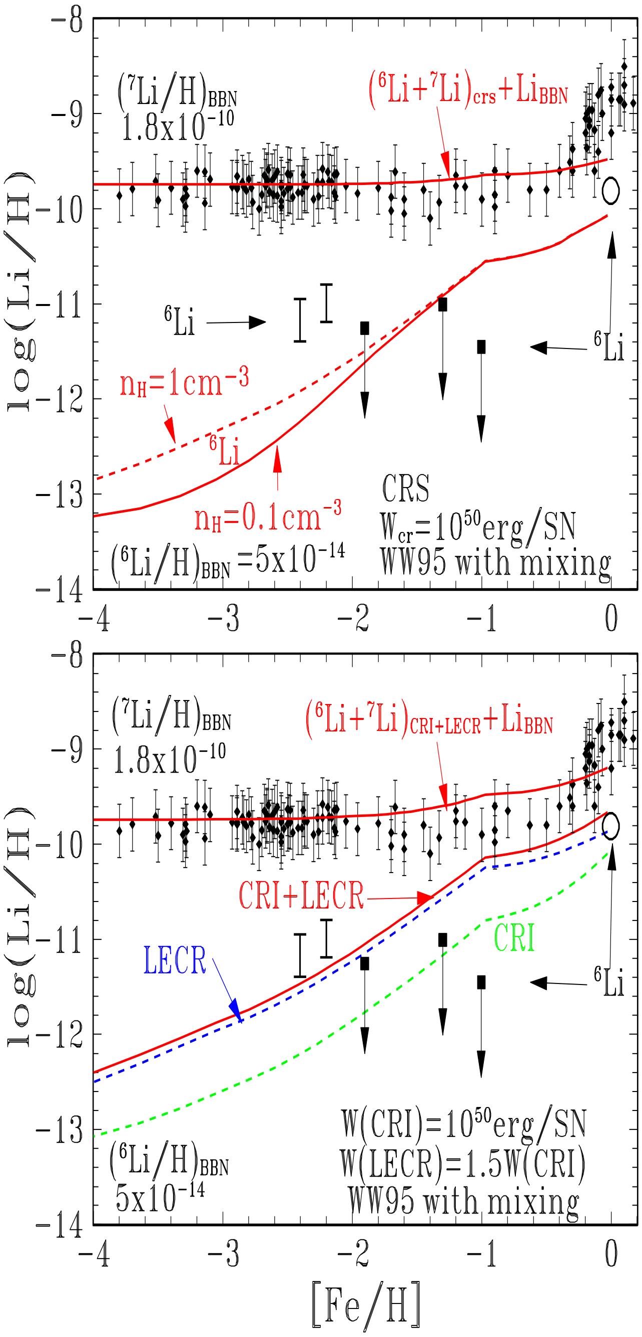
The CRI+LECR model requires ν−contribution because at [Fe/H]=0 CRI dominates

The rise of $^{11}B/^{10}B$ from the meteoritic value for CRI+LECR is due to the combined effects of the larger $^{11}B/^{10}B$ for LECRs and the ν contribution of pure ^{11}B

The rise at [Fe/H]=−2 for n_H=0.1 (CRS) is due to the delayed deposition of the cosmic ray produced B and Be

FIGURE 11.

Li evolution



CRS

underproduces data at [Fe/H]<−2, and also marginally at [Fe/H]=0
The upper limit at [Fe/H]=−1 reflects ^{6}Li destruction on the star in question

CRI+LECR

leads to more ^{6}Li but still underproduces the data at [Fe/H]<−2 and leads to overproduction of ^{6}Li and total Li later on

Data at [Fe/H]<−2 suggests a plateau, i.e. an extragalactic origin

FIGURE 12.

Li production by accelerated ^{3}He and α particles interacting with He

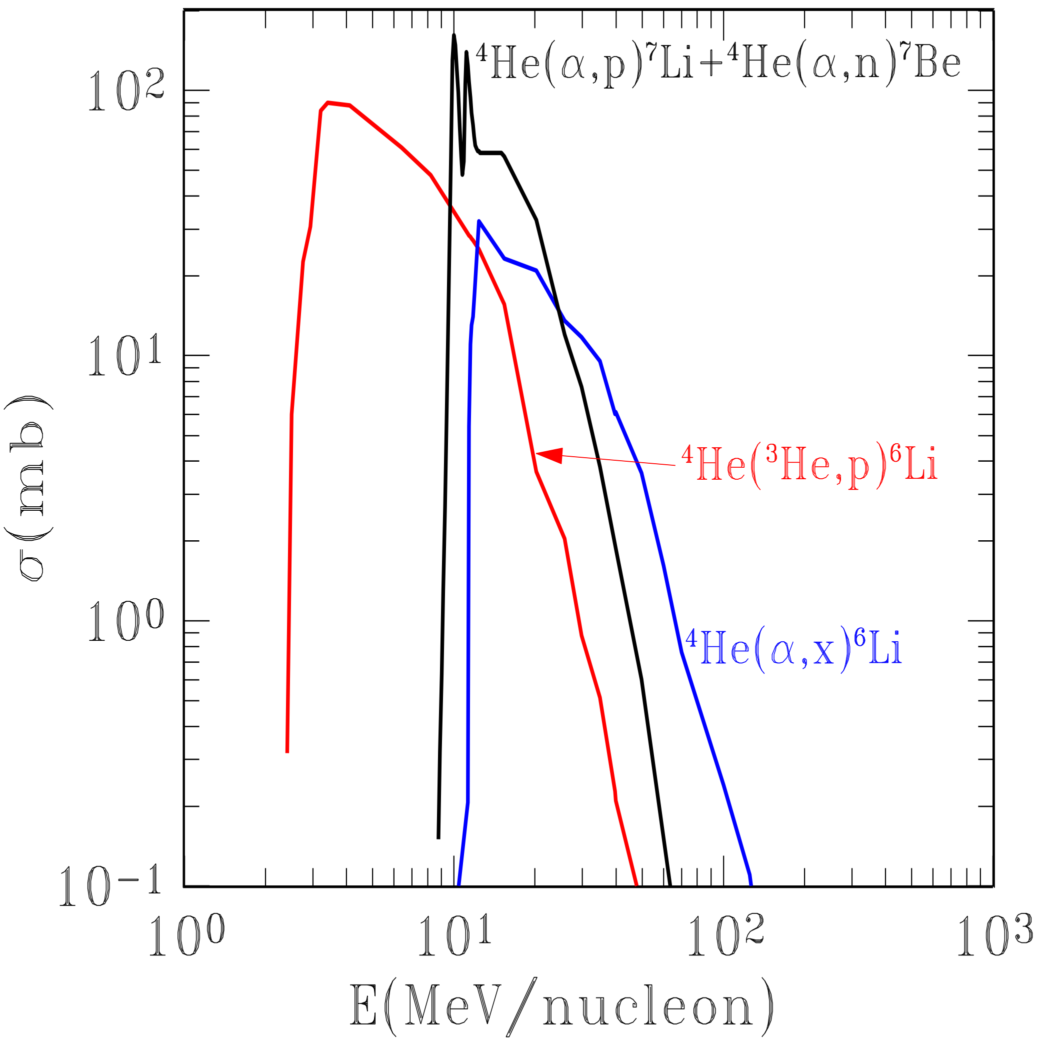
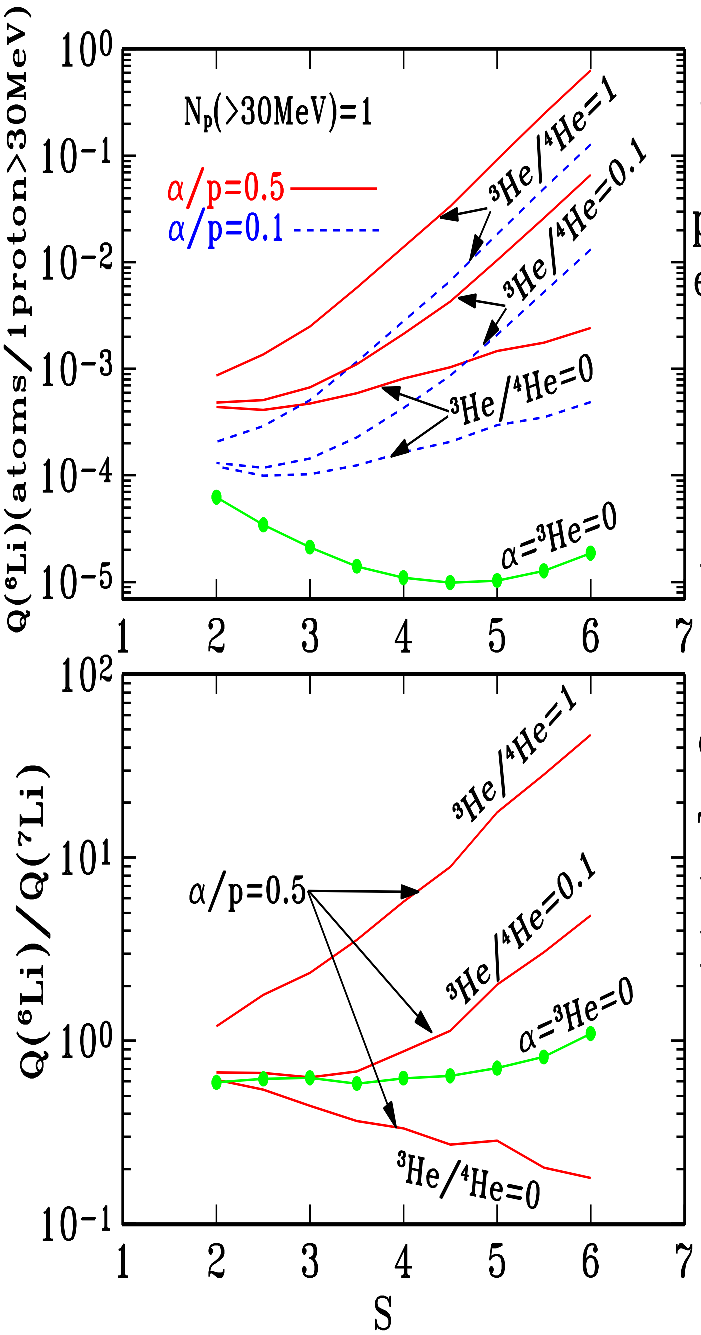


FIGURE 13.

Li production in solar flares



Accelerated particle energy spectra power law in kinetic energy/nucleon E^{-s}

There is evidence that in the accelerated particles the ratio of α particles to protons and ^3He to α particles can be on the order of 1

Then for steep spectra the bulk of the Li is ^6Li produced mostly by fast ^3He

FIGURE 14.

Li evolution in the CRS model with additional ^{6}Li from post BBN era

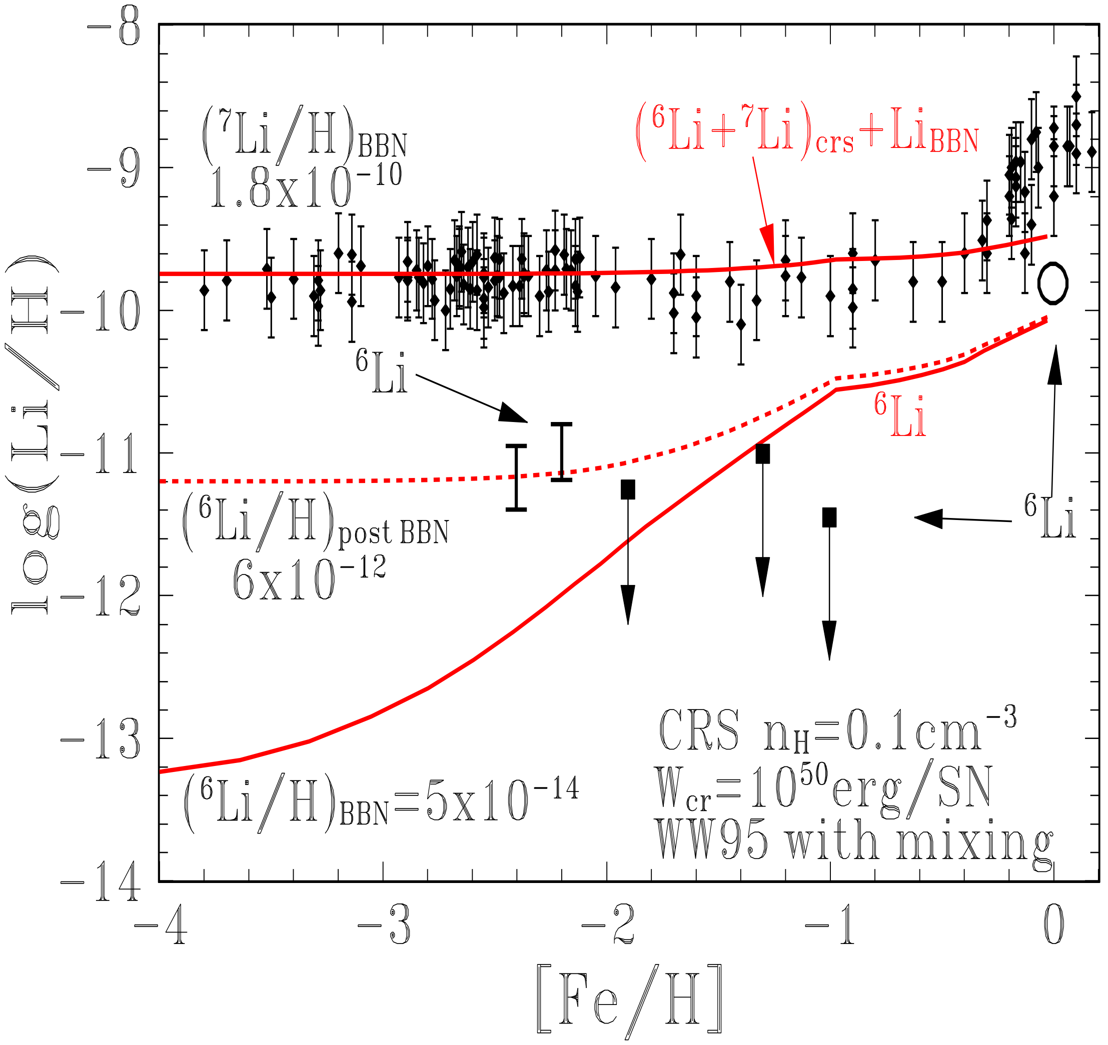


FIGURE 15.