

# GW150914: why so massive?

A. Bressan (SISSA & INAF)

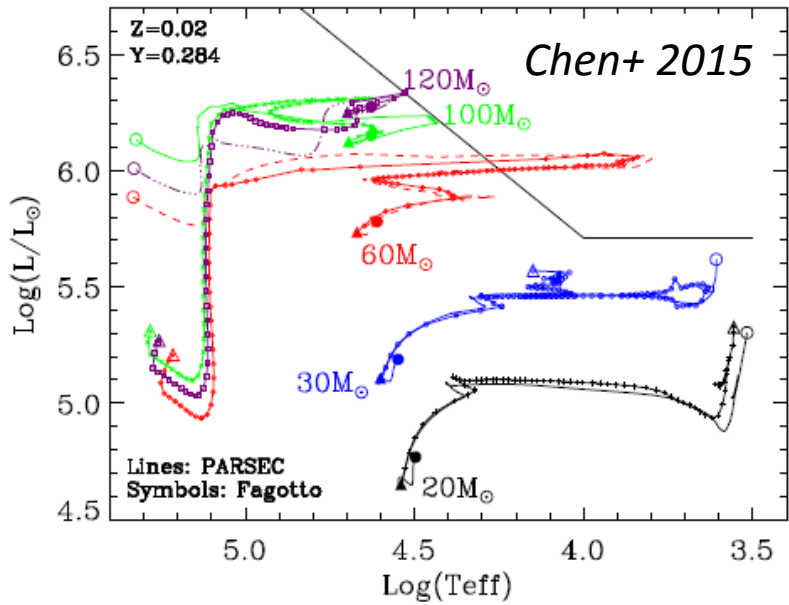
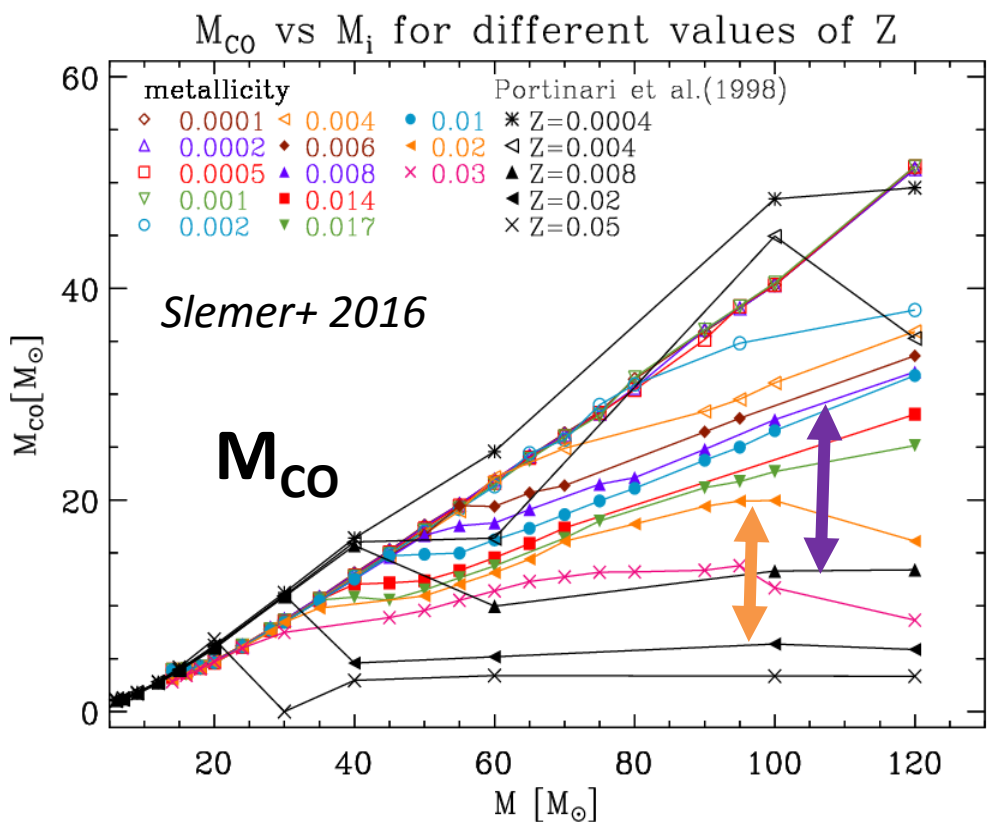
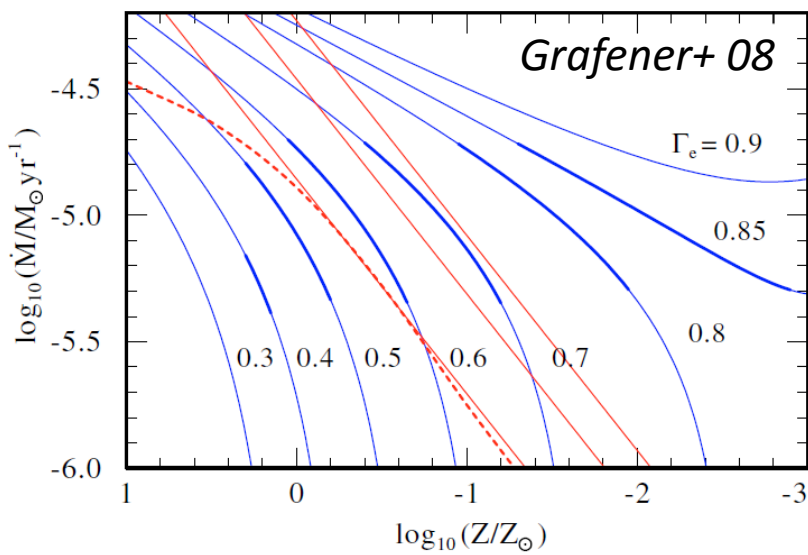
Basic reasons: mass-loss & mixing

With new mass-loss rates

( $\sim Z^{0.85}$  Vink+00,01,05,11; Grafener+ 08)

➤  $M_{FI}$  &  $M_{CO}$  for solar and  $\sim$ sub-solar Z larger by about  $\sim 2$

# New Mass-Loss Rates



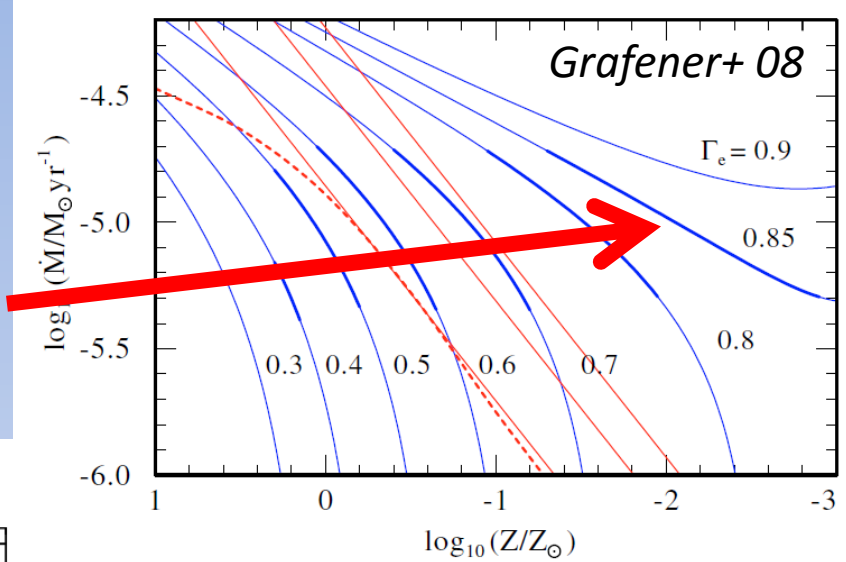
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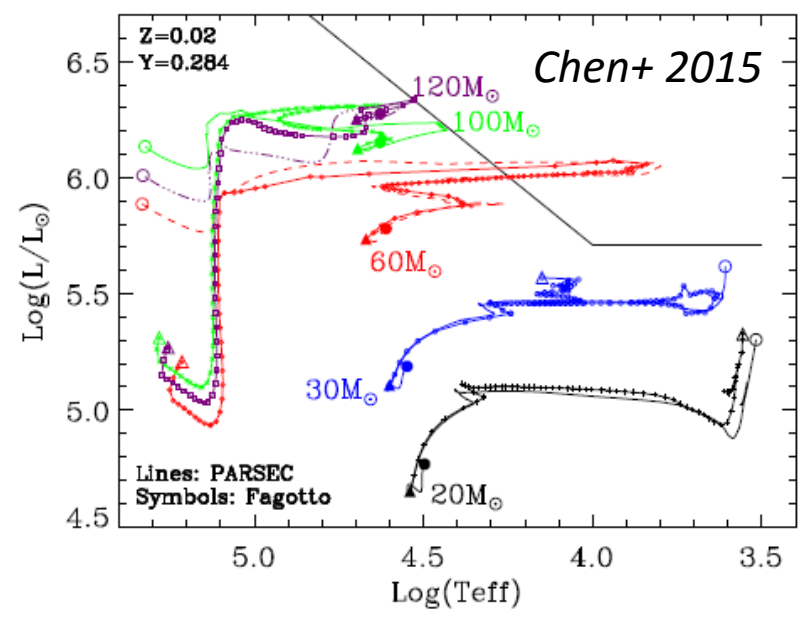
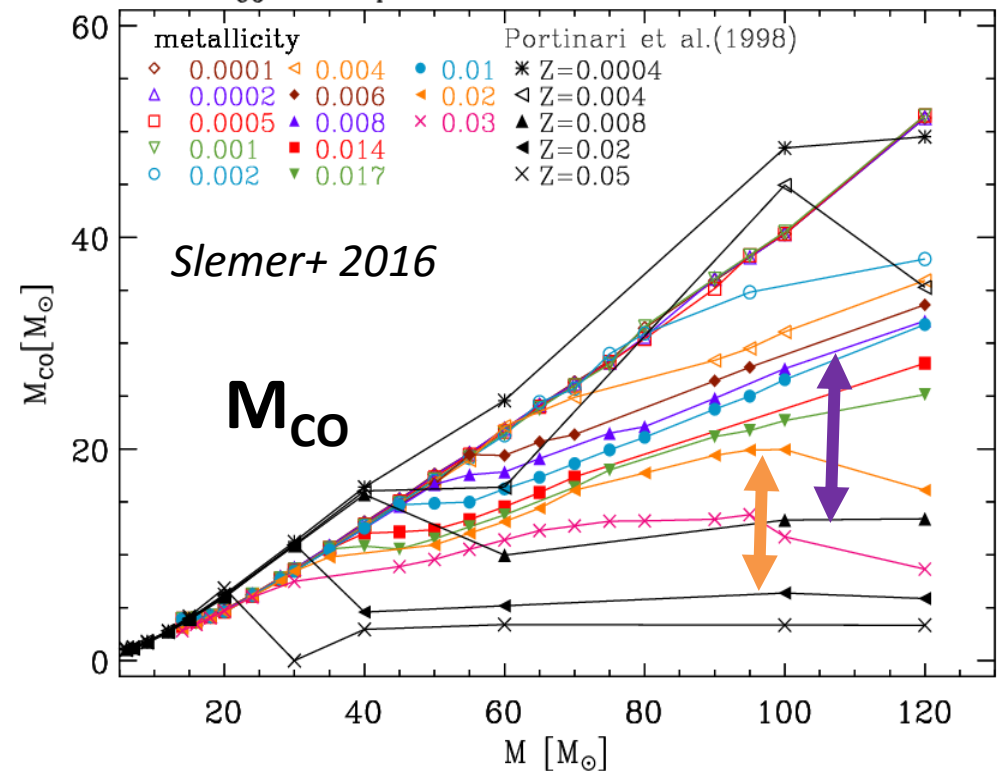
With new mass-loss rates  
(Vink+00,01,05,11; Grafener+ 08)

➤ **Relevance of the Eddington Factor**  
**VMS may still loose significant mass**

## New Mass-Loss Rates



$M_{\text{CO}}$  vs  $M_i$  for different values of Z



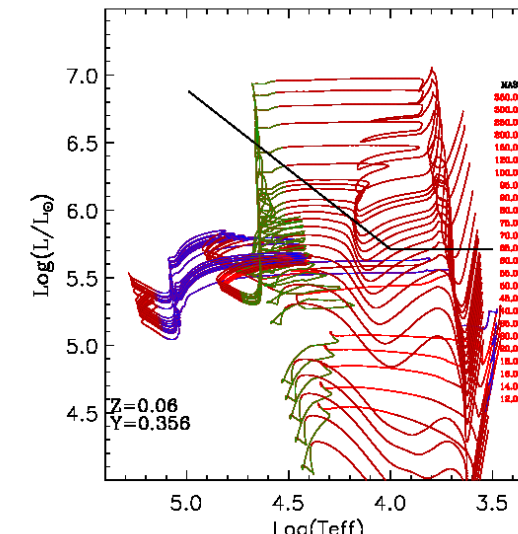
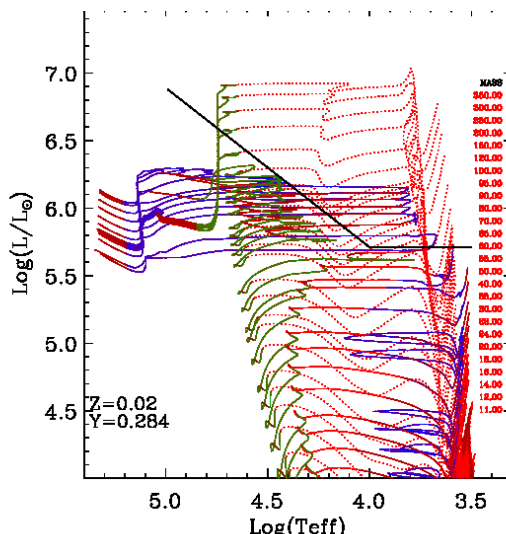
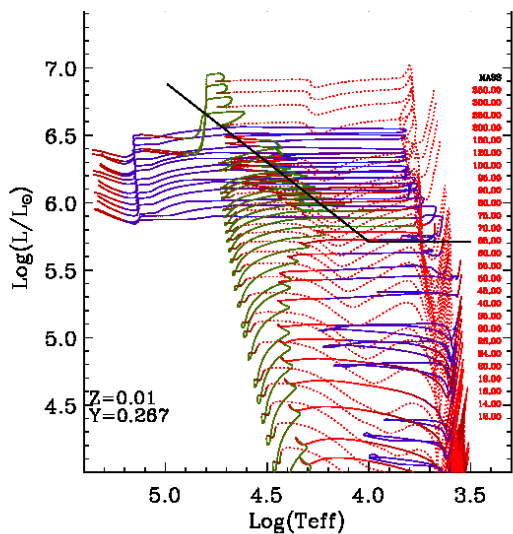
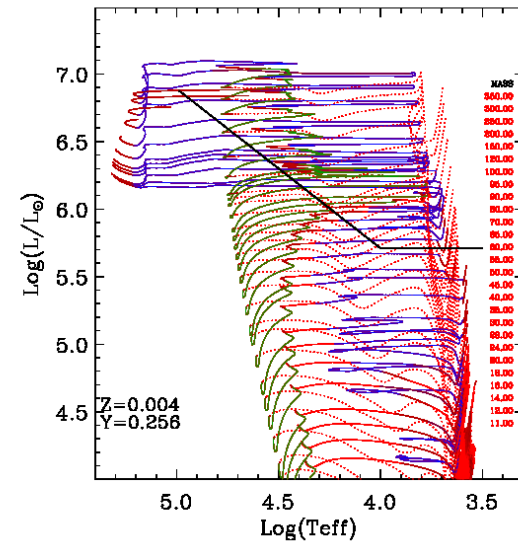
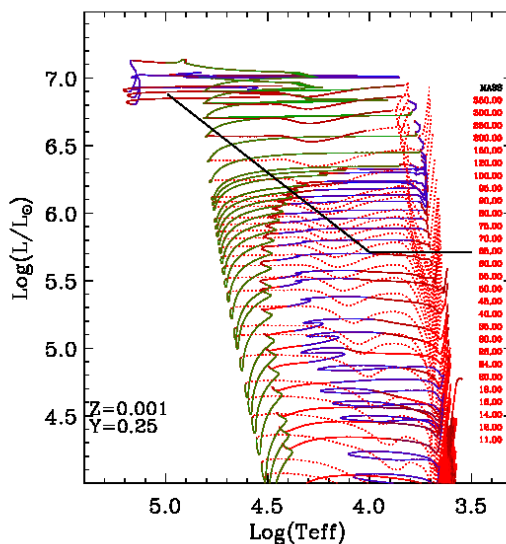
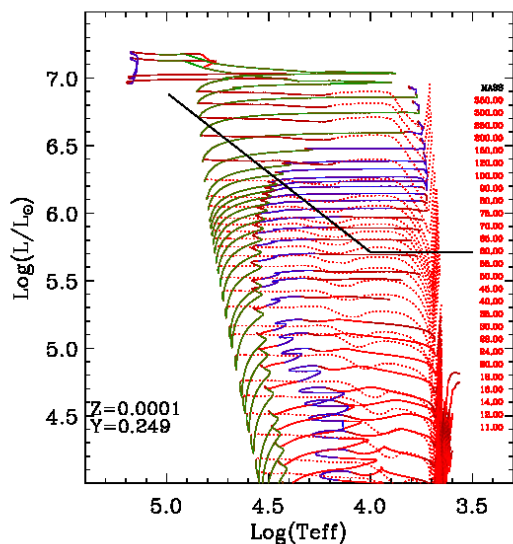
# PARSEC (Bressan+ 12, Tang+ 14, Chen+ 15)

The Largest Database of Stellar Evolutionary Tracks for Population

Synthesis purposes <http://people.sissa.it/~sbressan/parsec.html>

14 metallicity sets

0.1 M<sub>☉</sub> - 350 M<sub>☉</sub>



# Remnant Masses (& Z-Yields)

(Slemer+16)

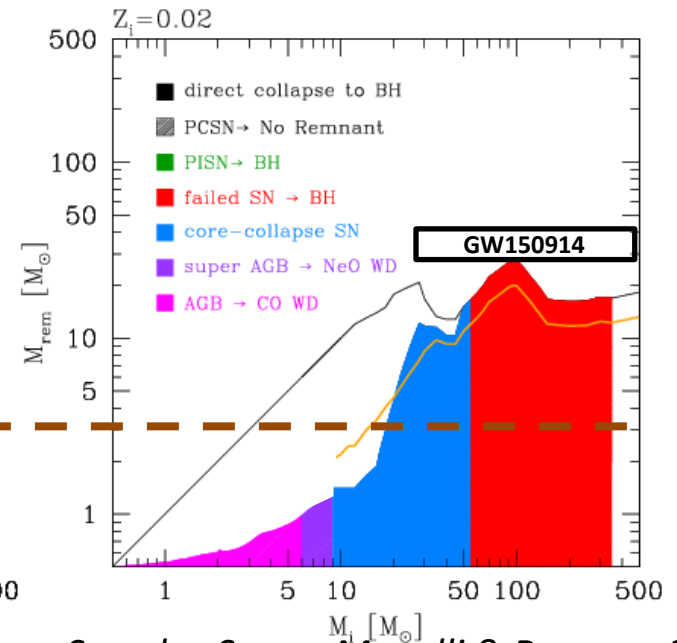
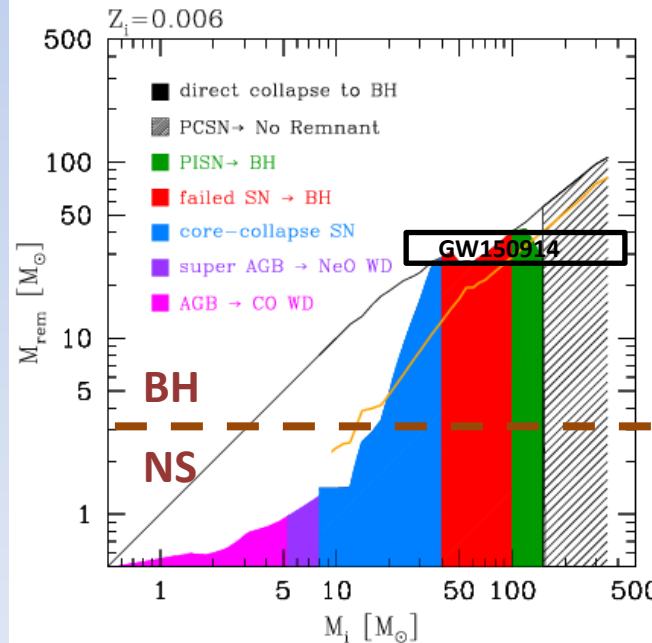
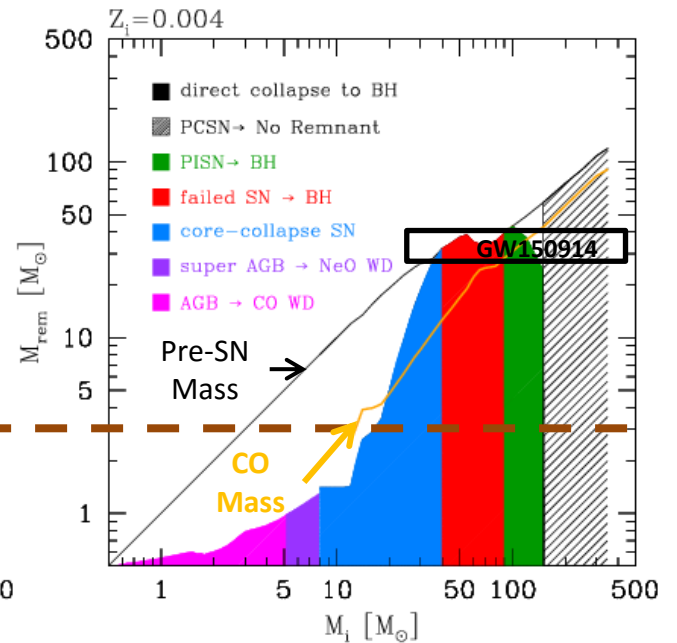
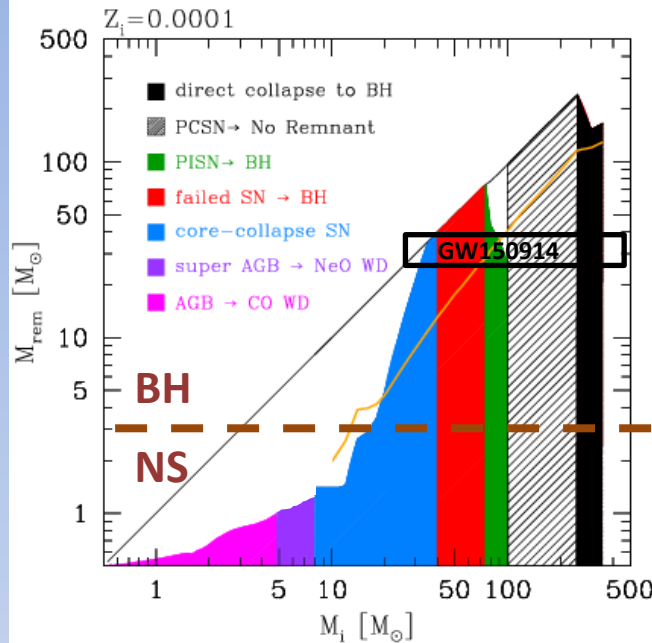
Adopt:

PARSEC

Massive Stars  
(Bressan+12)

+

Delayed SN Mod.  
(Fryer+12)



See also Spera, Mapelli & Bressan 2015

# Remnant Masses (& Z-Yields)

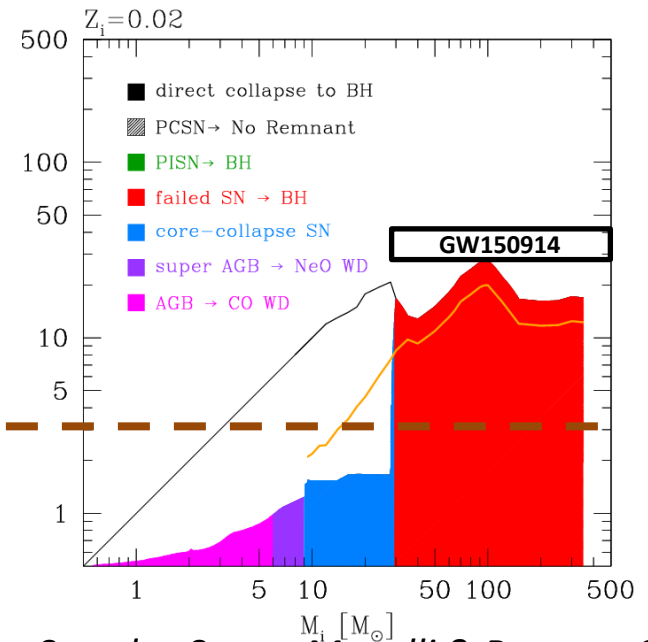
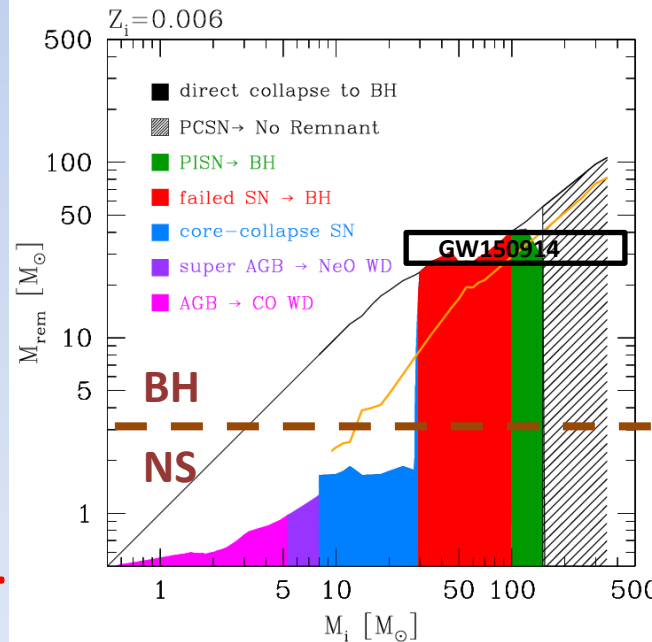
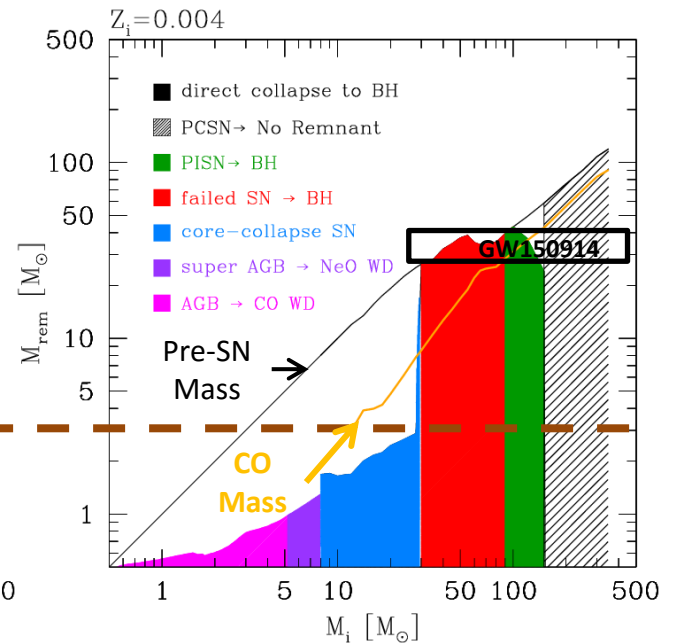
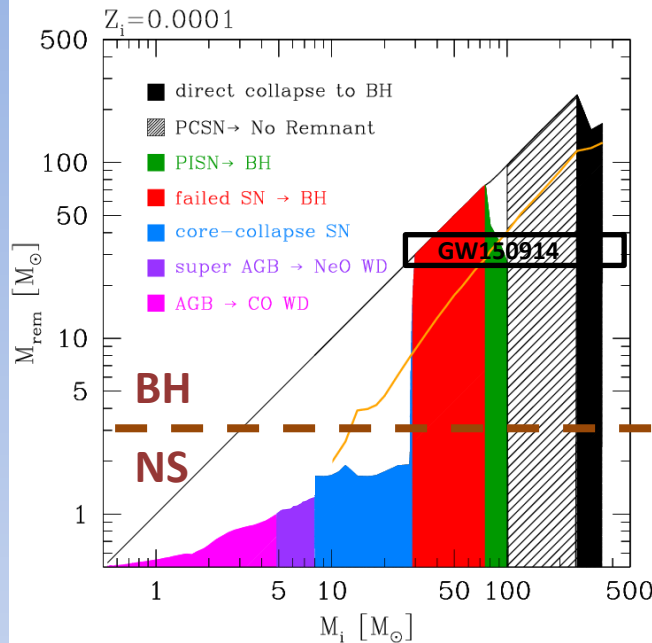
(Slemer+16)

Adopt:

PARSEC  
Massive Stars  
(Bressan+12)  
+  
Bi-Parametric  
SN Model  
(Ertl+16)

+

$M_{Ni}$  from SN mod.  
Chieffi & Limongi 02,06



See also Spera, Mapelli & Bressan 2015



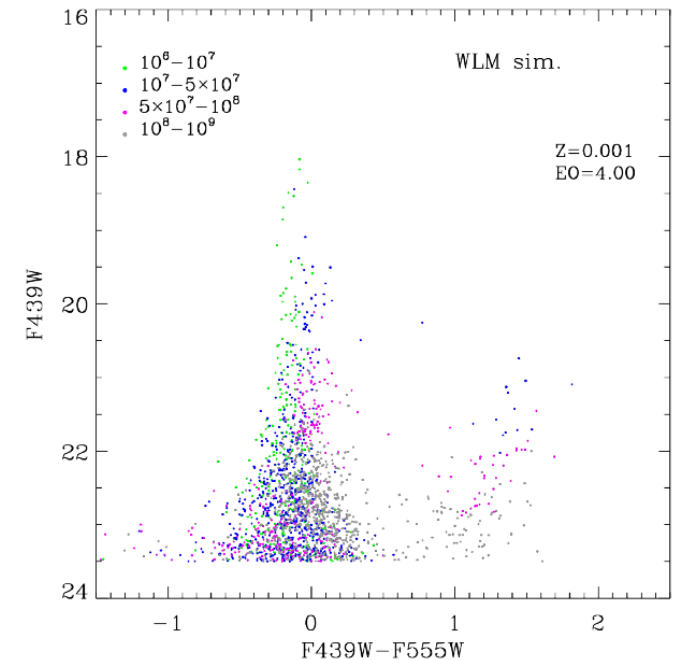
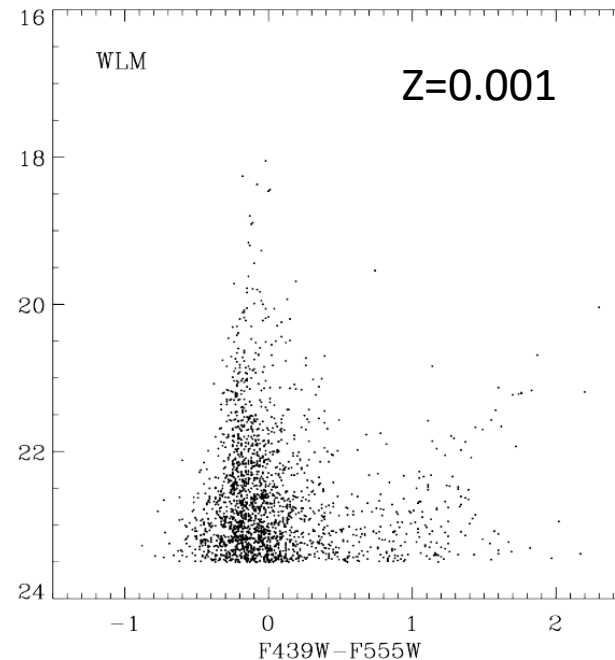
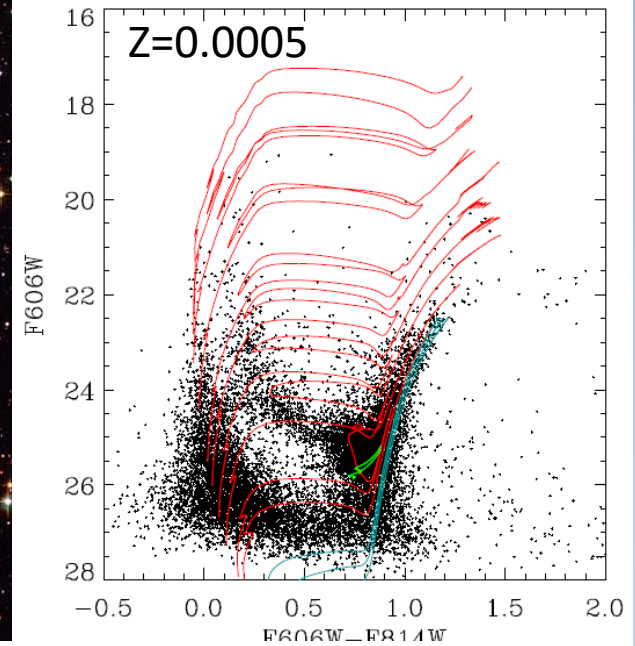
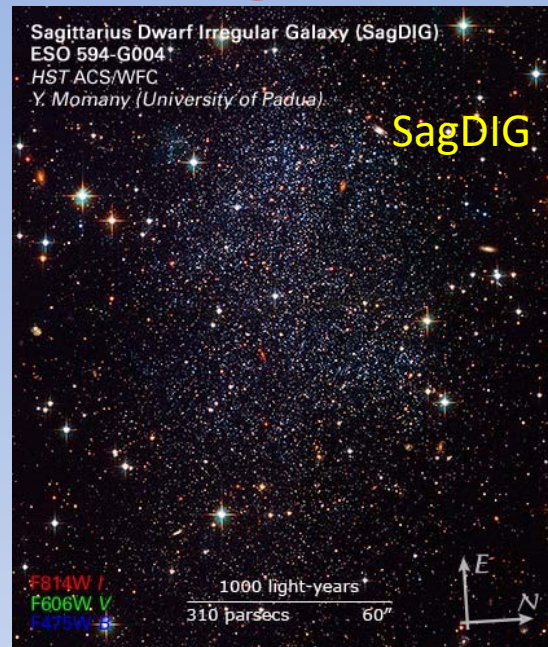
# Fundamental step: validating evolutionary tracks

## Dwarf Irregular Galaxies as ideal laboratories:

- Ongoing Star Formation
- $Z$  from spectroscopy
- HST photometry

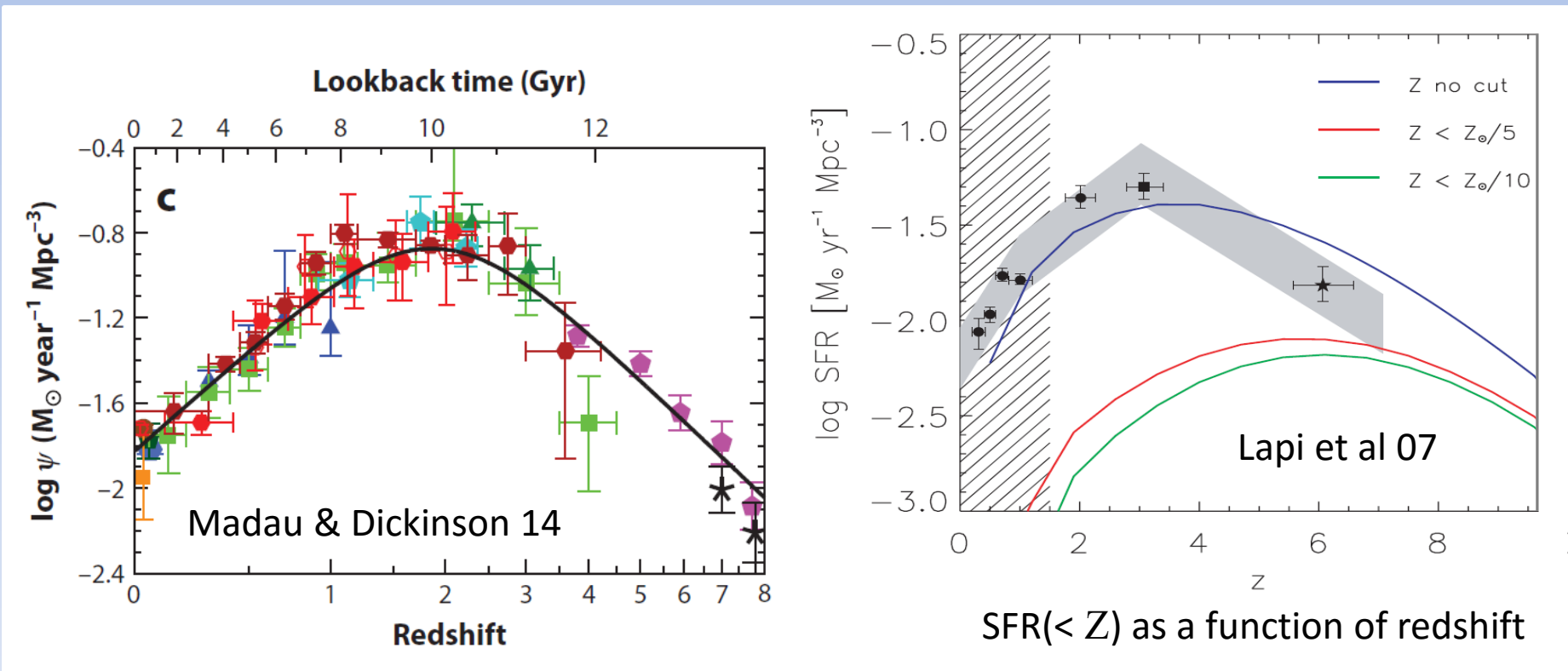
*Girardi+14; Tang+ 14, 15;  
Rosenfield+14,16;...*

*Test basic model assumptions :  
mass-loss, mixing*



# Which Host for GW150914 ?

Answer to this question need a full understanding of the formation path



# MASS - METALLICITY in local ellipticals

Closed model

Open model

