UNIVERSITÀ DEGLI STUDI DI TRIESTE

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OSSERVATORIO ASTRONOMICO DI TRIESTE

^{26}Al and ^{60}Fe in the LMC

Prediction of abundances for future ɣ-ray surveys

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Outline

- Introduction:
    - nuclear properties and observations
- Chemical evolution model:
    - Chemical evolution equation
    - Chemical prescriptions
    - Star Formation Rates and Initial Mass Function
- Results:
    - Observational constraints
    - Alfa elements (O, Mg, Si, Ca)
    - ^{26}Al mass and ^{60}Fe mass
- Conclusions

^{26}Al and ^{60}Fe: radioactive isotopes

Short-lived radioactive isotopes ($\sim$ Myr)

+

Produced by massive stars (in SF regions)

→ tracers of *star formation regions*

Observed in the Milky Way by COMPTEL and INTEGRAL (γ-ray surveys)

COSI could target the Large Magellanic Cloud

→ Need for theoretical predictions

^{26}Al and ^{60}Fe in the LMC

Chemical evolution model to study the abundances of ^{26}Al and ^{60}Fe in the LMC

SFR

$$\dot{M}_{\mathrm{gas},i}(t) = -\psi(t)X_i(t) + X_{i,A}A(t) + \dot{R}_i(t) - \lambda_i M_{gas,i}(t)$$

Inclusion of elements into stars

Gas accretion due to gas infall

Stellar ejecta

Depletion due to radioactive decay

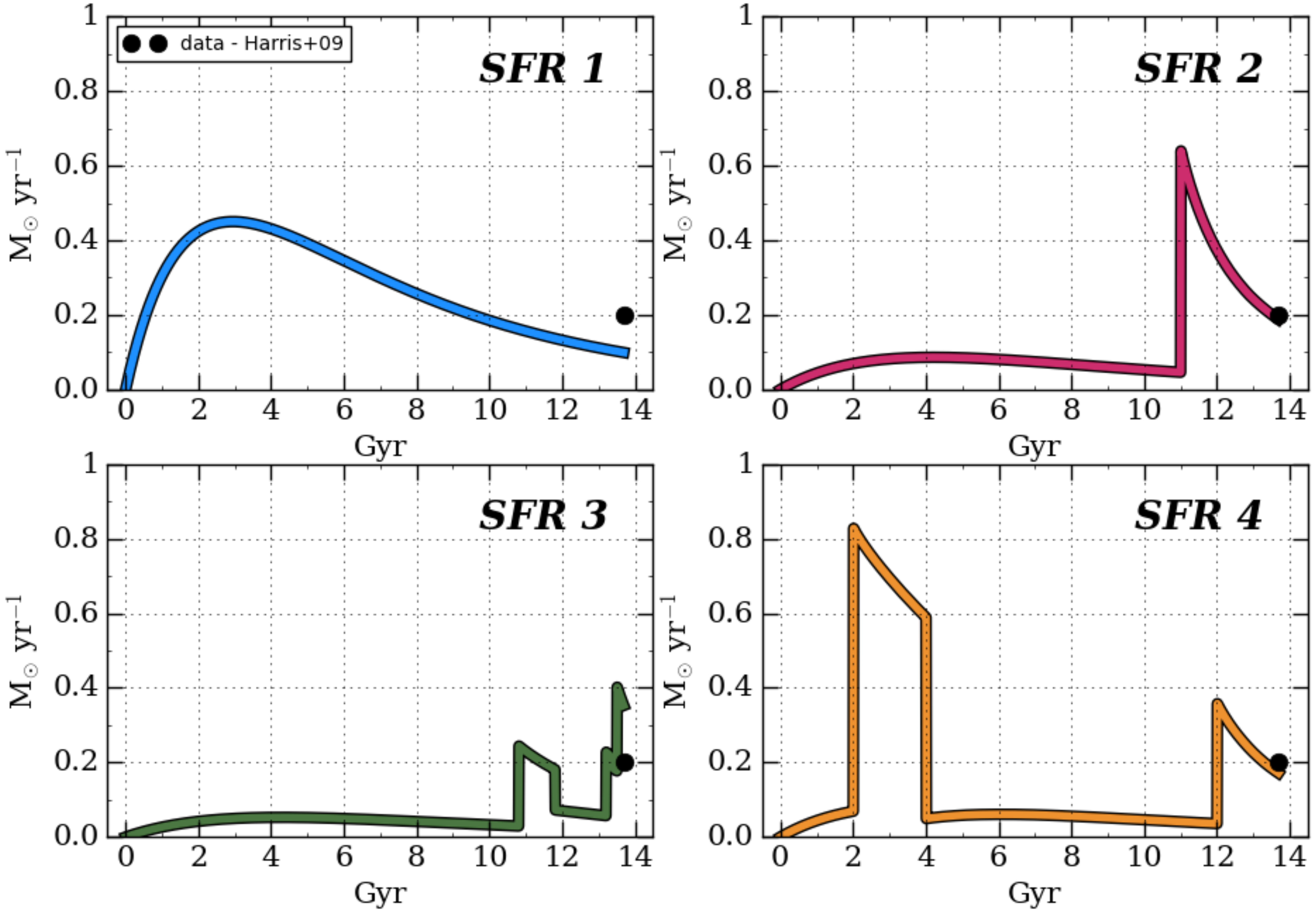
^{26}Al and ^{60}Fe in the LMC

- One-zone model
- Homogenous mixing
- No IRA (instantaneous recycling approximation)
- SFR: Schmidt-Kennicutt ’98 (constant efficiency)
- Infall time: 5 Gyr
- Wind efficiency: 0.25 Gyr^{-1}
- SNII, SNIa, novae
- Single infall ⟶ $A(t,R) = c_1 e^{-t/\tau_{D1}}$

^{26}Al and ^{60}Fe in the LMC: SFR + IMF

4 tests:

- *Kennicutt 98 + Kroupa 93*
- *Hasselquist+21+ Kroupa 01*
- *Harris & Zaritsky 09 + Salpeter 55*
- *Calura+03 + Salpeter 55*



^{26}Al and ^{60}Fe in the LMC: constraints

Present time observational constraints:

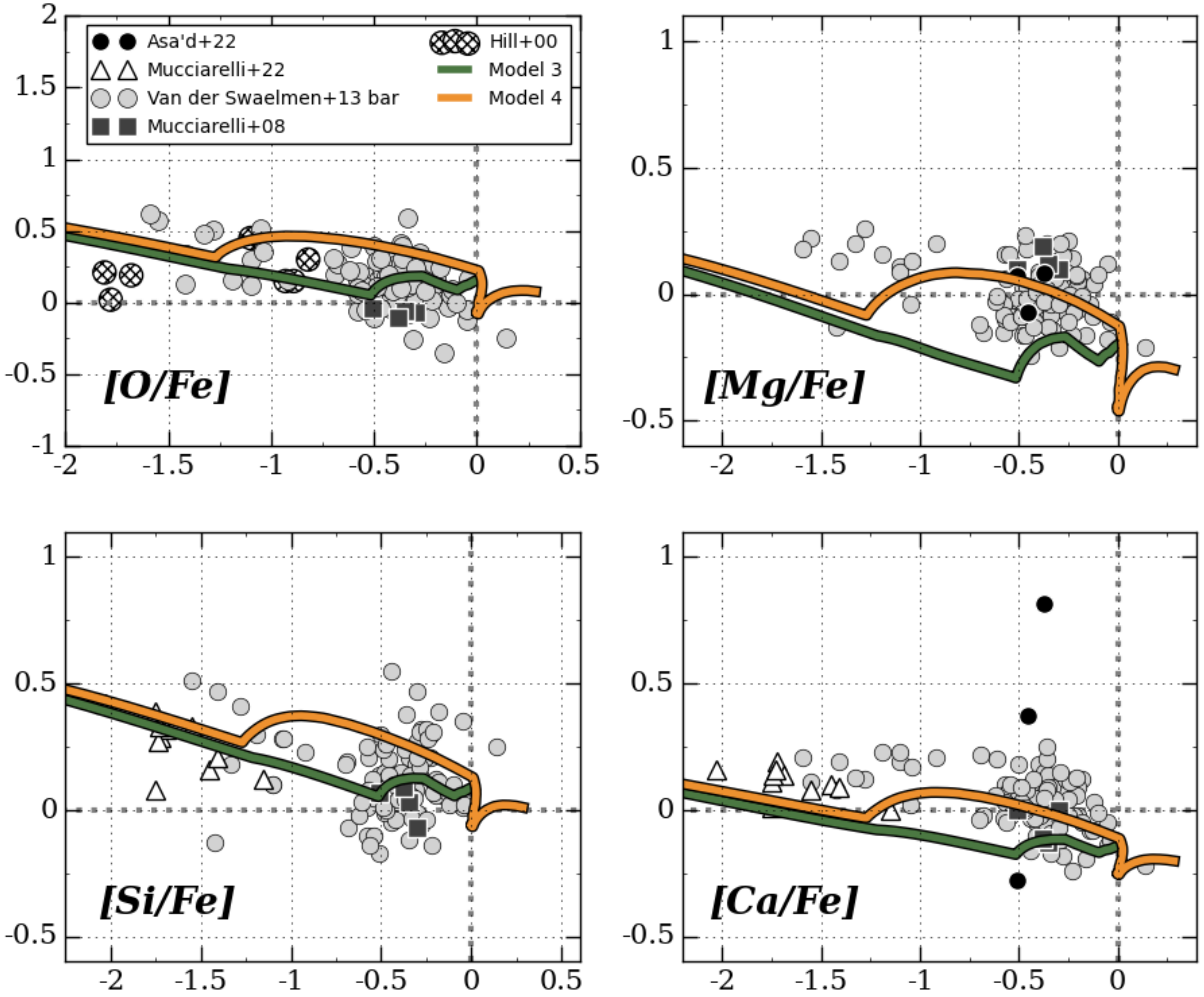
- **Metallicity Z**: 1/3 - 1/2 of the solar metallicity
- **SNII**: $0.46^{+0.38}_{-0.27}$ SN century^{-1} (Mannucci+05)
- **SNIa**: $0.21^{+0.11}_{-0.08}$ SN century^{-1} (Mannucci+05)
- **Nova outburst**: 2.4 ± 0.8 novae yr^{-1} (Mroz+16)
- **SFR**: 0.2 $M_\odot$ yr^{-1} (Harris&Zaritsky09)

→

Best models:

- Harris & Zaritsky 09
- Calura+03

^{26}Al and ^{60}Fe in the LMC: alfa elements



Alfa elements comparison:

- **Model 3 (H&Z09)**
- **Model 4 (Calura03)**

↓

Best model:
Harris & Zaritsky 09 + Salpeter 55

Results: ^{26}Al and ^{60}Fe mass

^{26}Al yields:

- Massive stars: Woosley & Weaver 1995
- Novae: Josè & Hernanz 2007

→ ^{26}Al mass: **0.33 $M_\odot$**

1/3 novae + 2/3 massive stars

^{60}Fe yields:

- Massive stars: Woosley & Weaver 1995
- No novae

→ ^{60}Fe mass: **0.44 $M_\odot$**

Conclusions

- The best LMC model is the Harris & Zaritsky 2009 SFR + Salpeter 1955 IMF:

it reproduces better the observational constraints and the alfa element abundances

- We predict 0.33 $M_\odot$ of ^{26}Al and 0.44 $M_\odot$ of ^{60}Fe in the LMC

- We observe more ^{60}Fe than ^{26}Al: the reason is the Salpeter IMF