Chemodynamical Simulation of the Milky Way Galaxy

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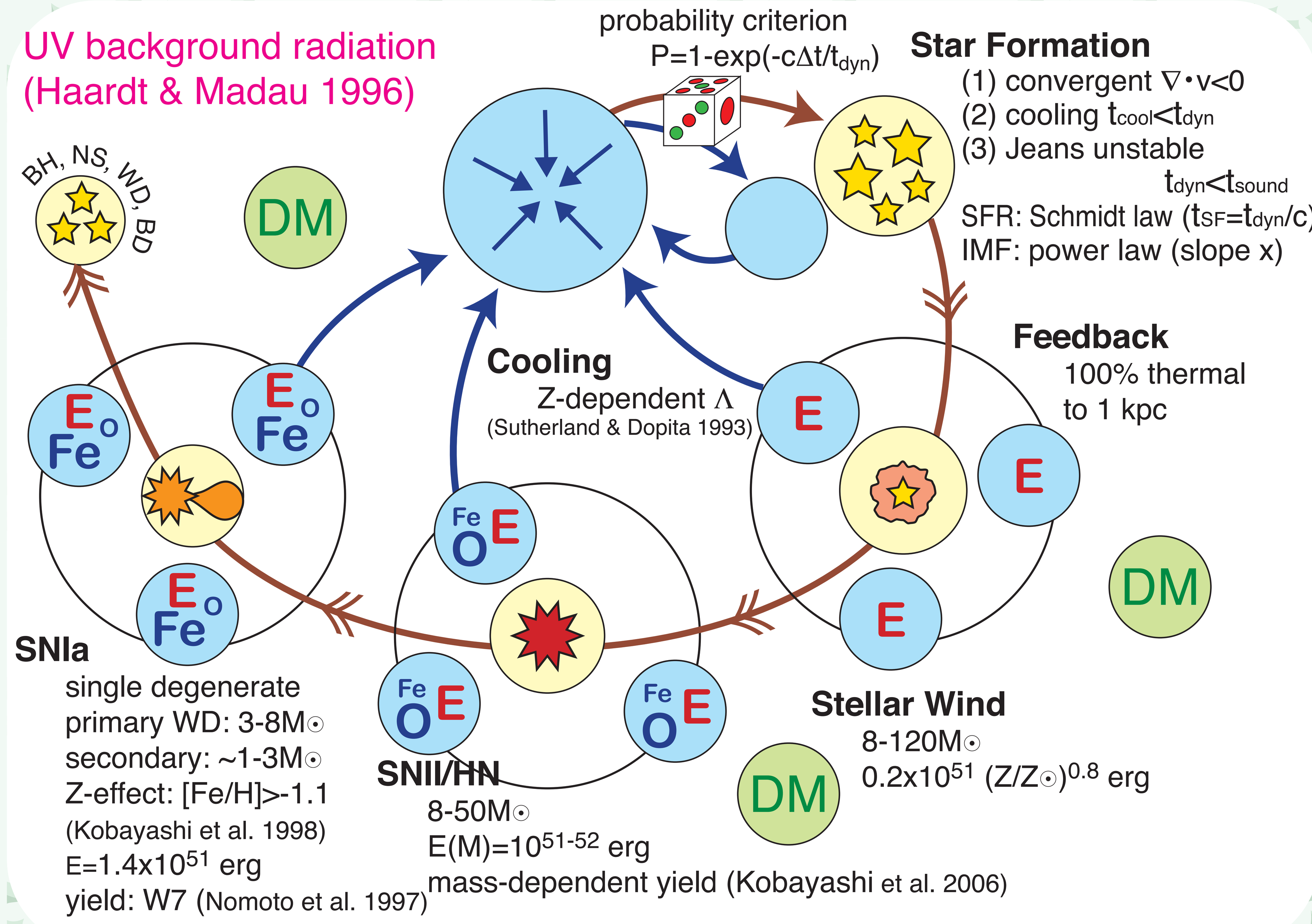
1. Abstract

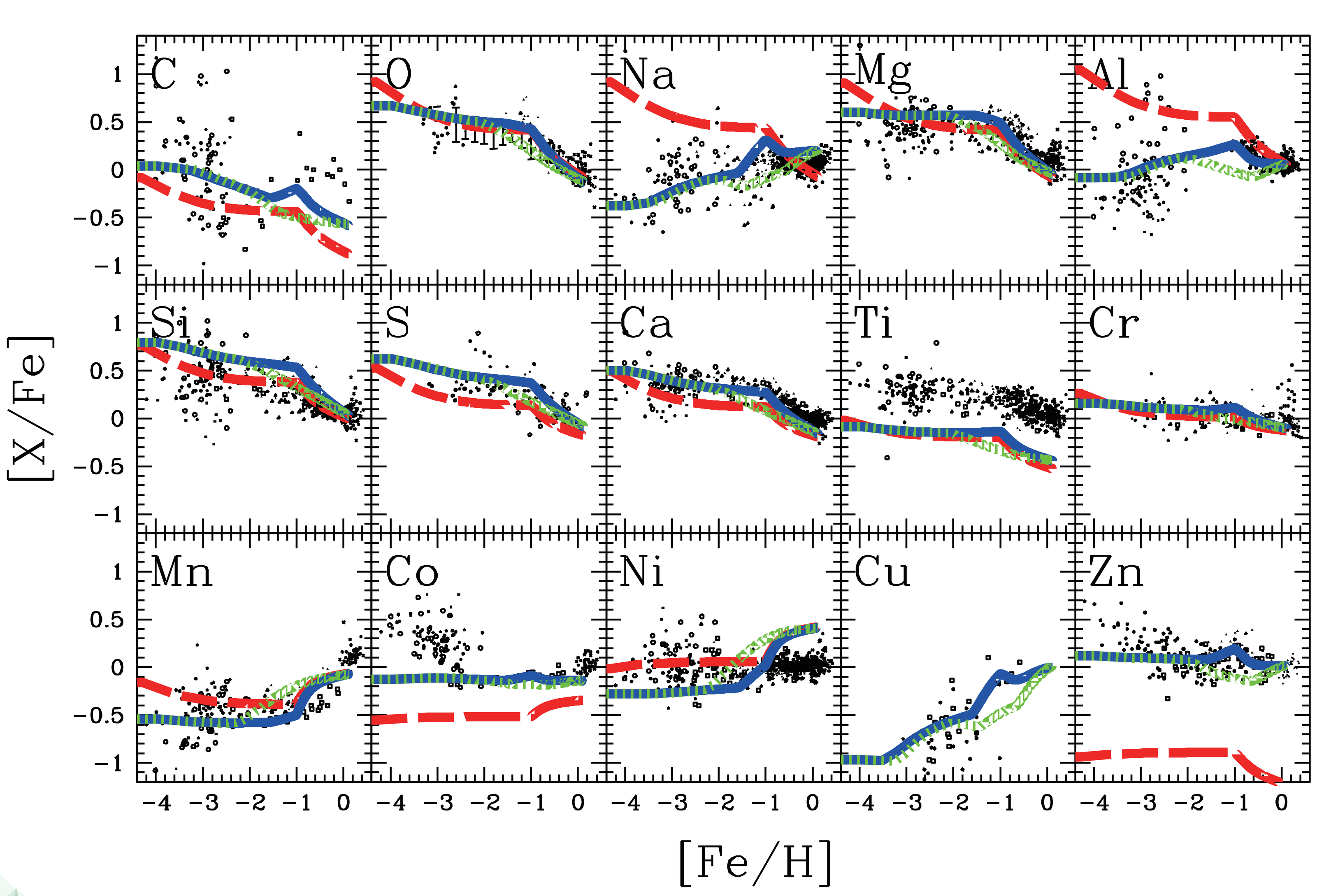
We simulate the evolution of baryons in the Universe, i.e., the formation and evolution of galaxies, with our chemodynamical code that includes star formation, Type II and Ia supernova feedback, and chemical enrichment. The star formation history of galaxies is imprinted in the elemental abundances of stellar populations, and and we solve this by comparing simulations with observations (**Galactic Archaeology**).
The ejected Fe mass and explosion energy from core-collapse supernovae can be determined from the light curve and spectra, and a large contribution of **hypernovae** (E_{51}>10, M>20M$_\odot$) is required from the observed abundance of Zn, i.e., [Zn/Fe]~0 (Kobayashi et al. 2006).
Our **SN Ia progenitor model** is based on the single degenerate scenario with the metallicity effect (Kobayashi et al. 1998), and is in better agreement with the observed [(α,Mn,Zn)/Fe]-[Fe/H] relations (Kobayashi & Nomoto 2008).
Using chemodynamical simulations of the Milky Way Galaxy, we predict the frequency distribution in the [X/Fe]-[Fe/H] diagrams from carbon to zinc. High resolution multi-pbject spectrographs such as **WFMOS** will provide an intellectual heritage that we can use forever to study not only galaxy formation and evolution but also stellar astrophysics and cosmology.

2. Model

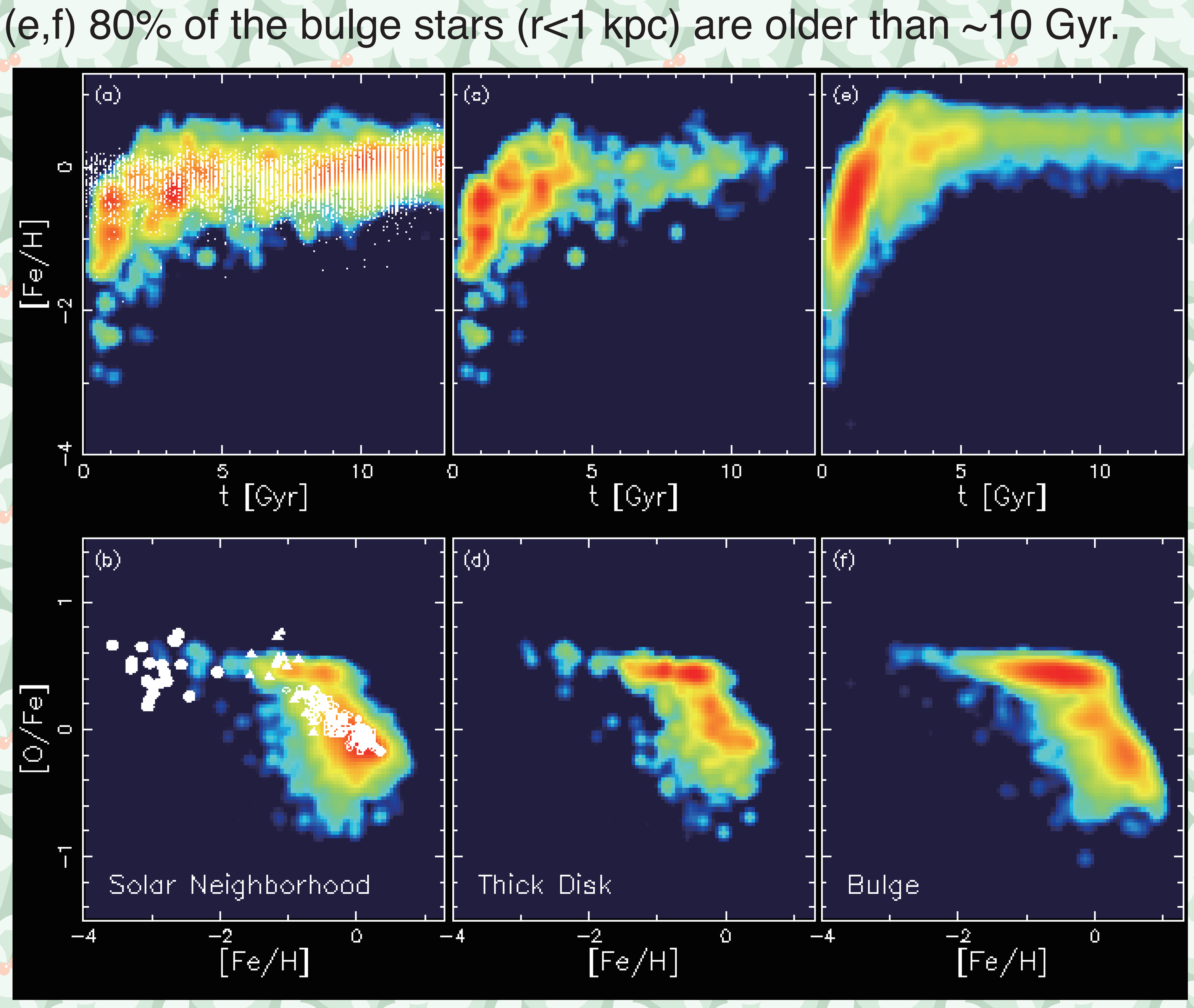


3. Supernova

Evolutions of heavy element abundance ratios [X/Fe] against [Fe/H] for **one-zone models** with our new yields (solid line, SNIa lifetime= 0.1-20 Gyr), and with only SNe II (dashed line), and with the double-degenerate scenario of SNe Ia (dotted line, SNIa lifetime ~0.3 Gyr). The dots are observational data.

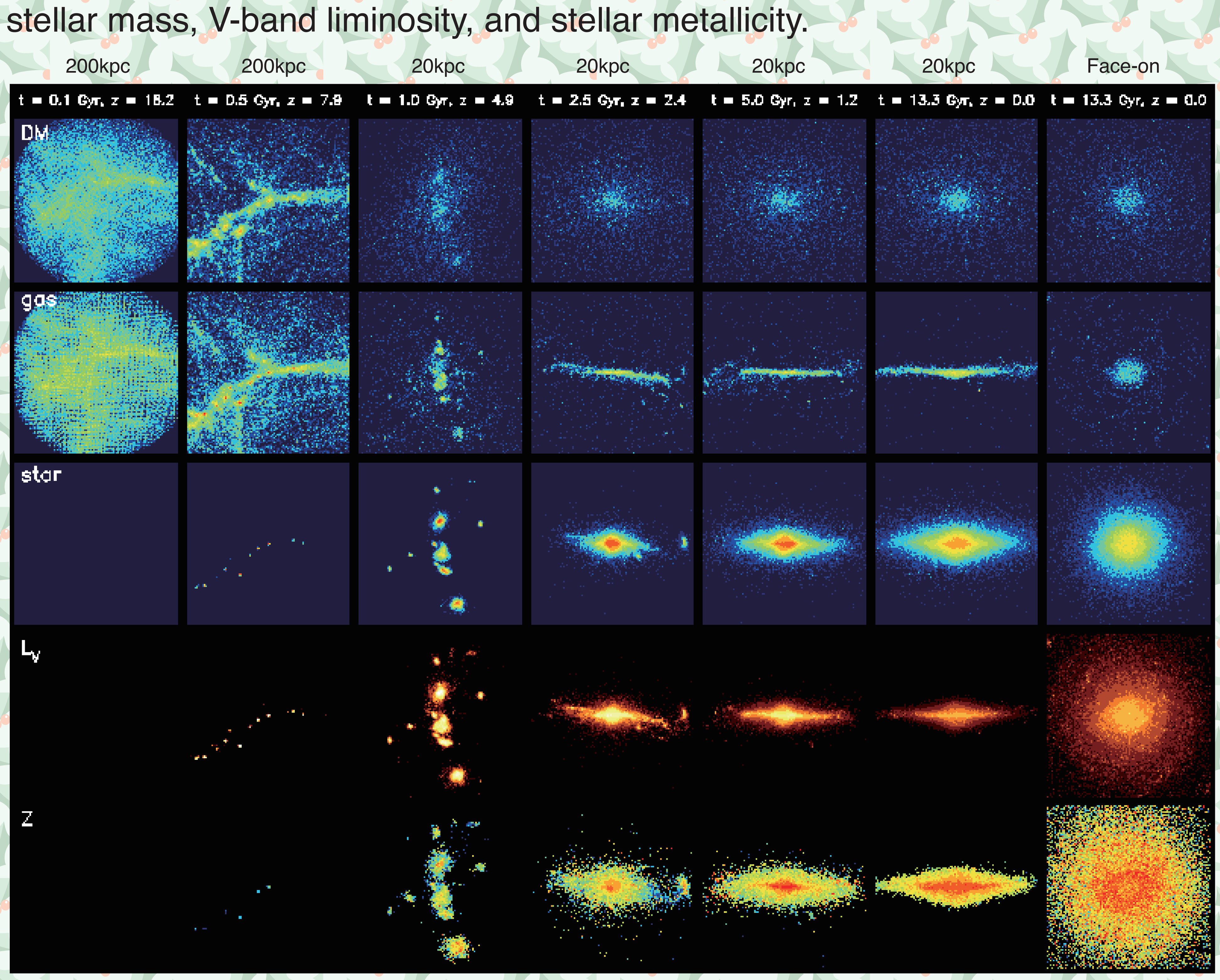


Age-Metallicity Relations and [α/Fe]-[Fe/H] Relations:
(a,b) In the solar neighborhood (r=7.5-8.5 kpc, |z|<0.5 kpc), 50% of the disk stars are younger than ~8 Gyr. (c,d) When we define thick disk as v/σ<1.5, 80% of thick disk stars are older than ~8 Gyr. (e,f) 80% of the bulge stars (r<1 kpc) are older than ~10 Gyr.



4. GRAPE-SPH Simulation

Time evoluton of our simulated Milky Way-type galaxy for dark matter, gas, stellar mass, V-band liminosity, and stellar metallicity.



Frequency distribution in the **[X/Fe]-[Fe/H] diagrams** in the solar neighborhood. Color contors and white dots are respectively for our simualtion and observations.