Understanding Chemical Evolution without Gas Masses

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First, A Thank You

Apertif

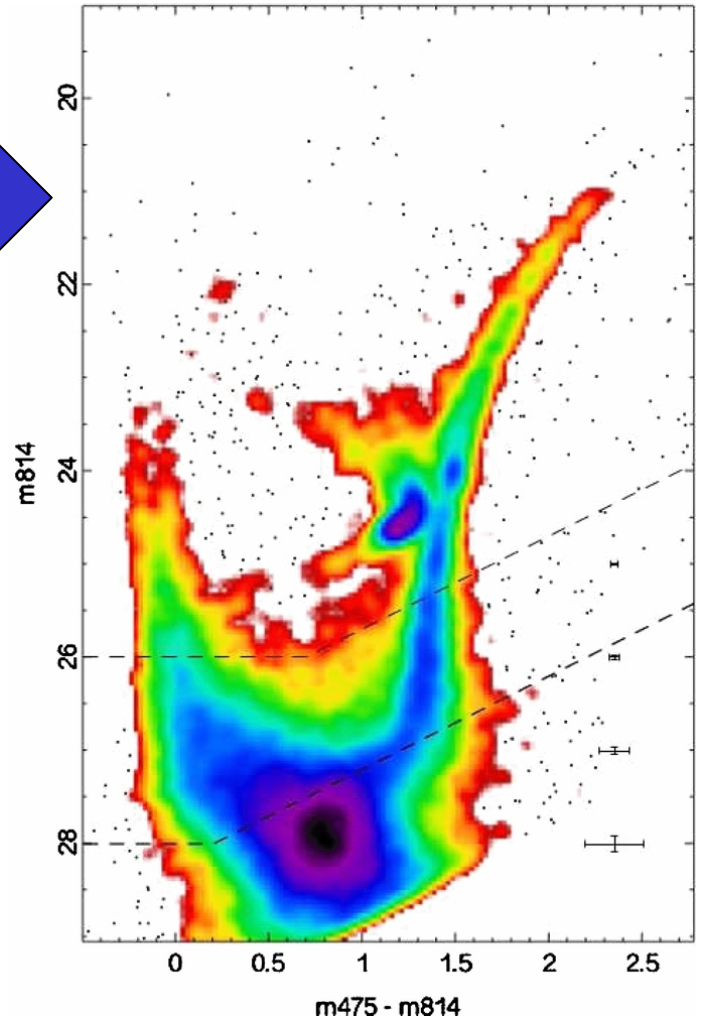
Because Thijs has invested so much into the Apertif project, I wanted my talk to be related to Apertif.

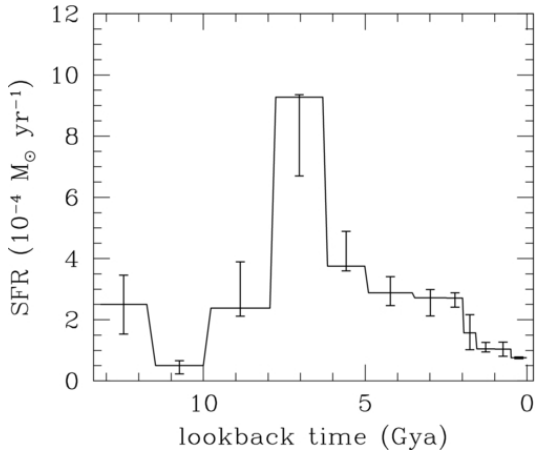
So, I started with the simple question, “What would I like to learn from the planned Apertif observations?”

Is there something that puzzles me, that Apertif will bring new insight to?

Here’s what I came up with:

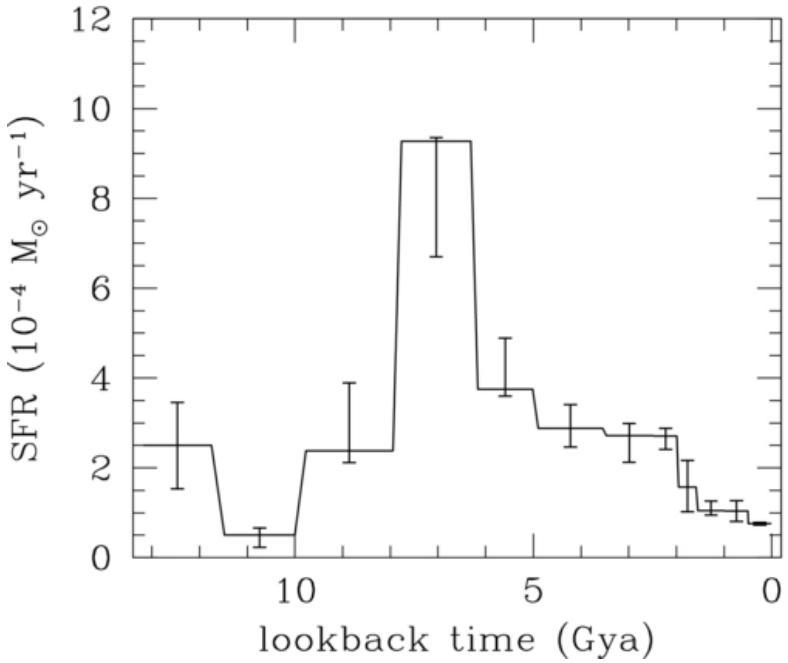
Resolved Galaxy Star Formation Histories:

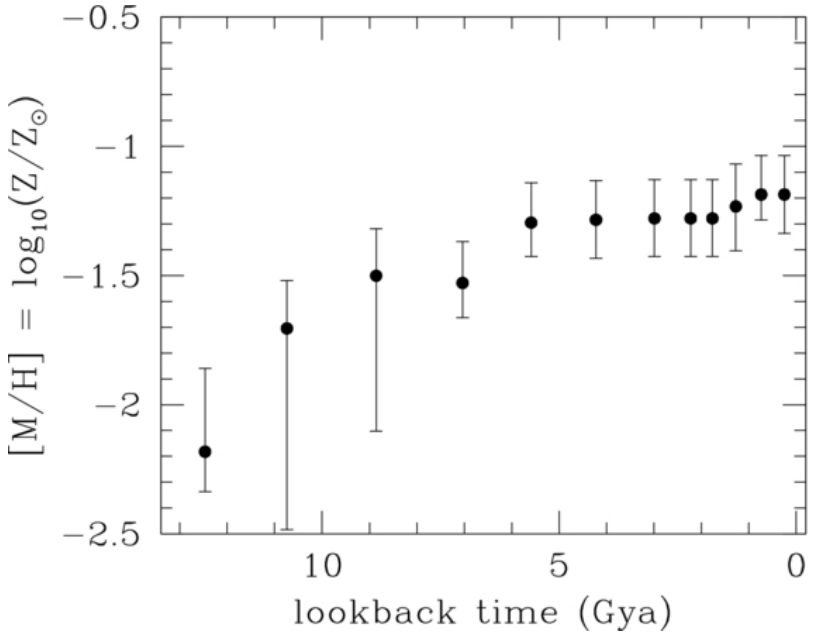




HST study of Aquarius Dwarf, Cole+ 2014

Resolved Galaxy Star Formation Histories:





The star formation history

The chemical evolution

HST study of Aquarius Dwarf, Cole+ 2014

Chemical Evolution

The chemical evolution of a galaxy reflects the effects of a number of processes:

Star formation creates new heavy elements

Galactic winds carry away both enriched and un-enriched gas

Infall brings in new gas, which could be pristine or enriched

Chemical Evolution

There are two equations which frame chemical evolution:

$Z_{gas} = y_{true} \ln (1/f_{gas})$ ("closed box")

$Z_{gas} = y_{eff} \ln (1/f_{gas})$ (allowing for inflows and outflows)

Where Z=metallicity, y=yield, and f_{gas} is gas mass fraction

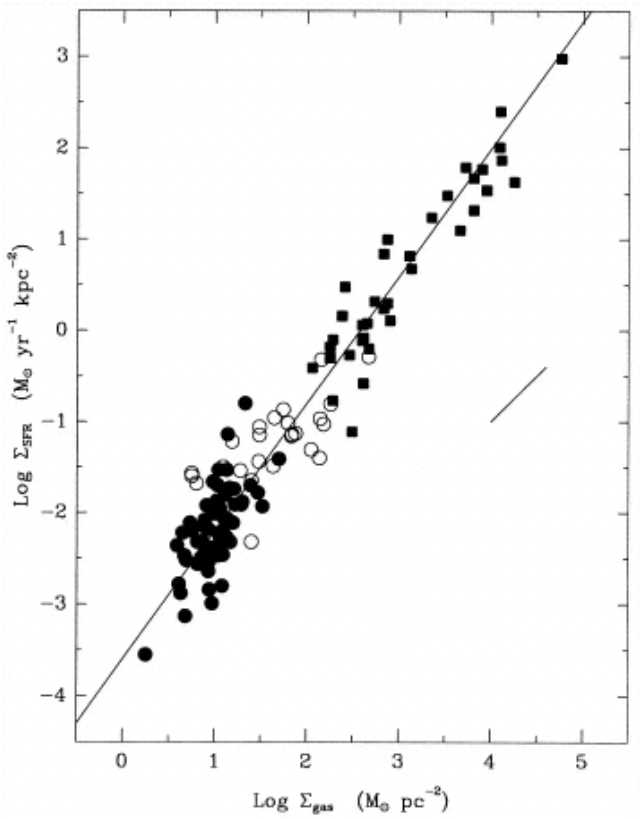
We can measure Z(t), but how do we interpret it if we can't measure f_{gas} (t)?

There is no equivalent to the low mass stars to record gas mass as a function of time.

We can calculate the metals produced from an episode of star formation, and we can measure the enrichment, but without knowing the gas mass we don't know the retention fraction.

A Work-Around?

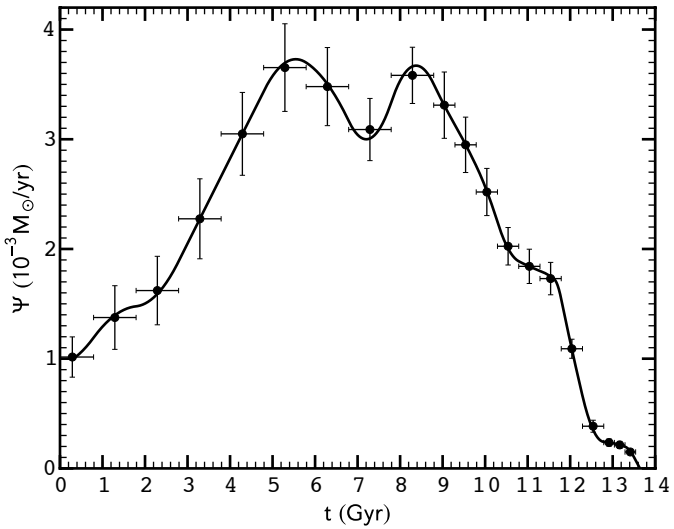
Because of this:

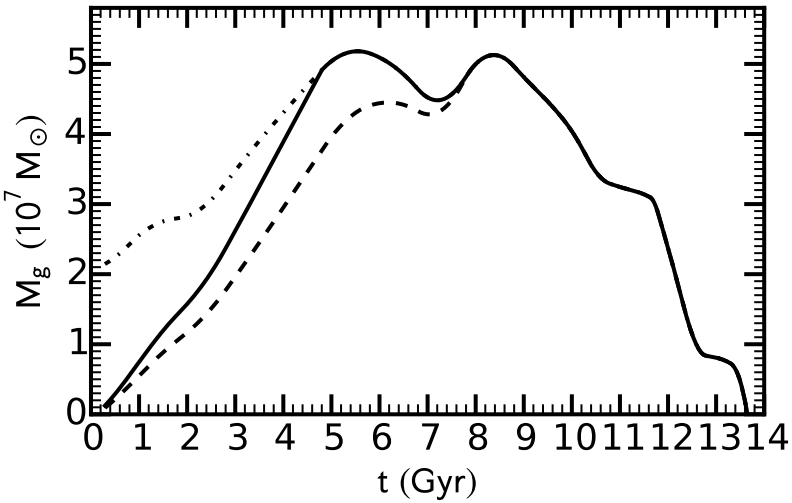


Kennicutt 1998

A Work-Around?

You can do this:





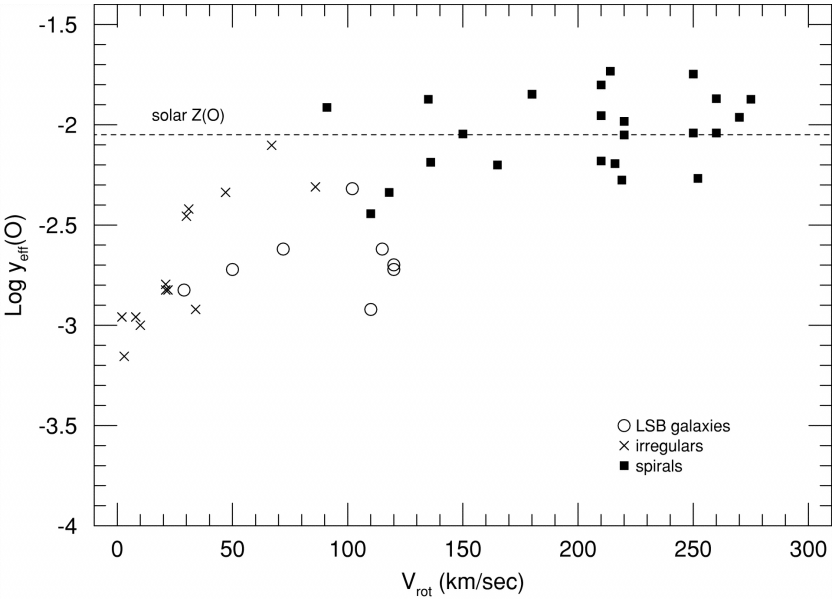
De Boer+ 2012

Yuan+ 2015

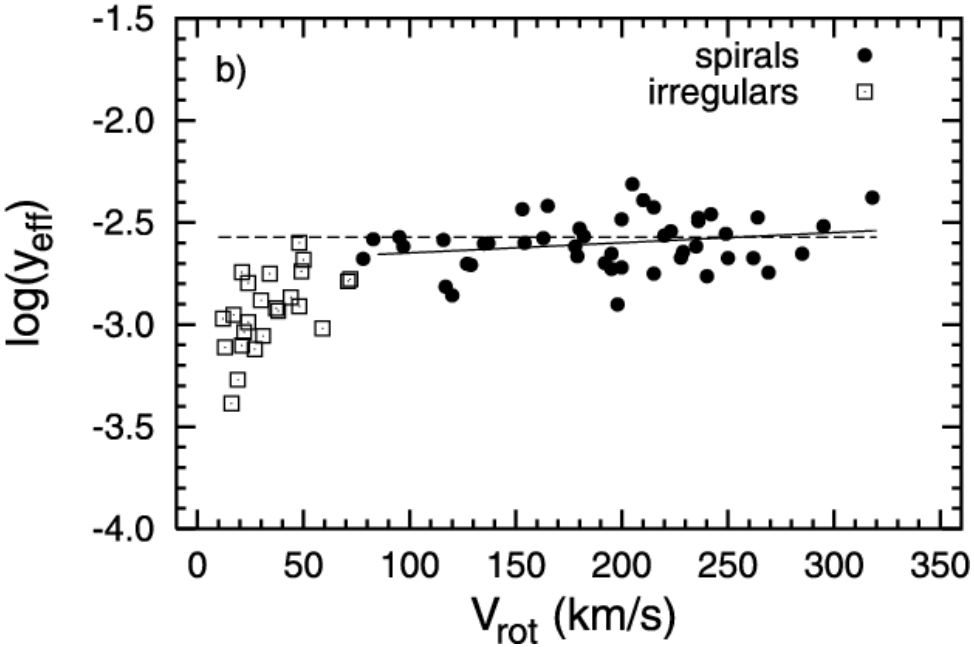
Does this mean we don't need to measure gas masses?

For Example

A very important question is what fraction of newly synthesized heavy elements is lost via galactic winds?



Garnett 2002

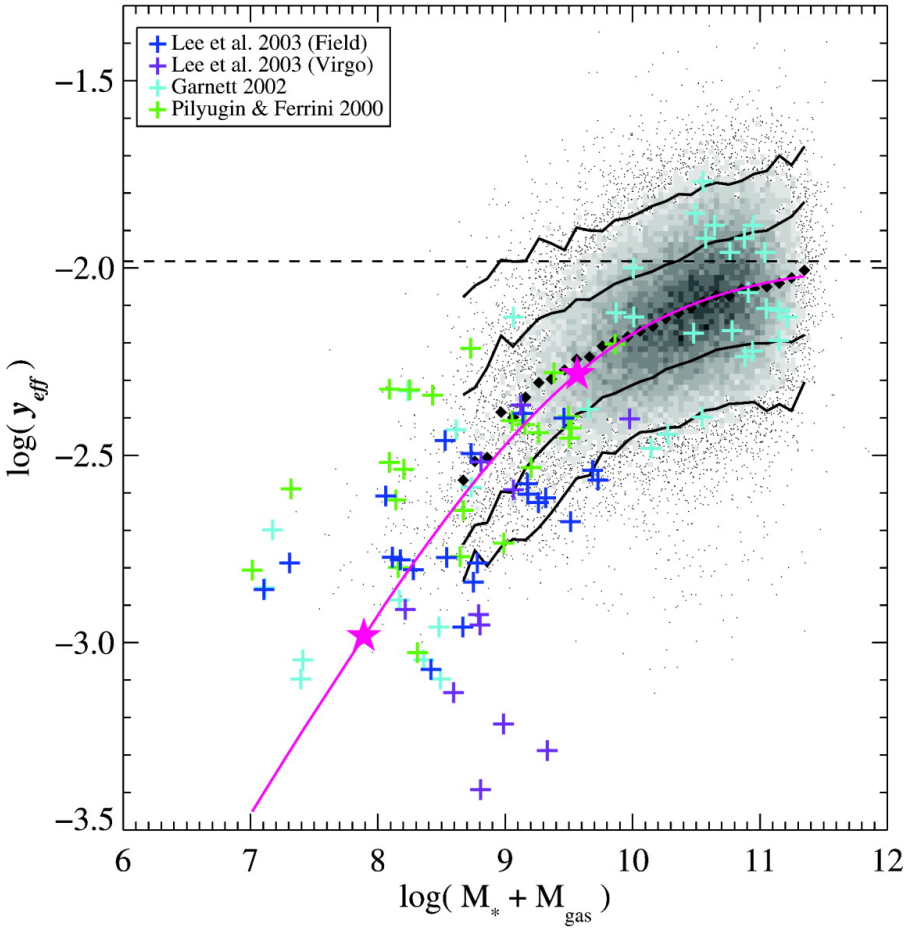


Pilyugin+ 2004

This is a relatively small sample size!

One Example

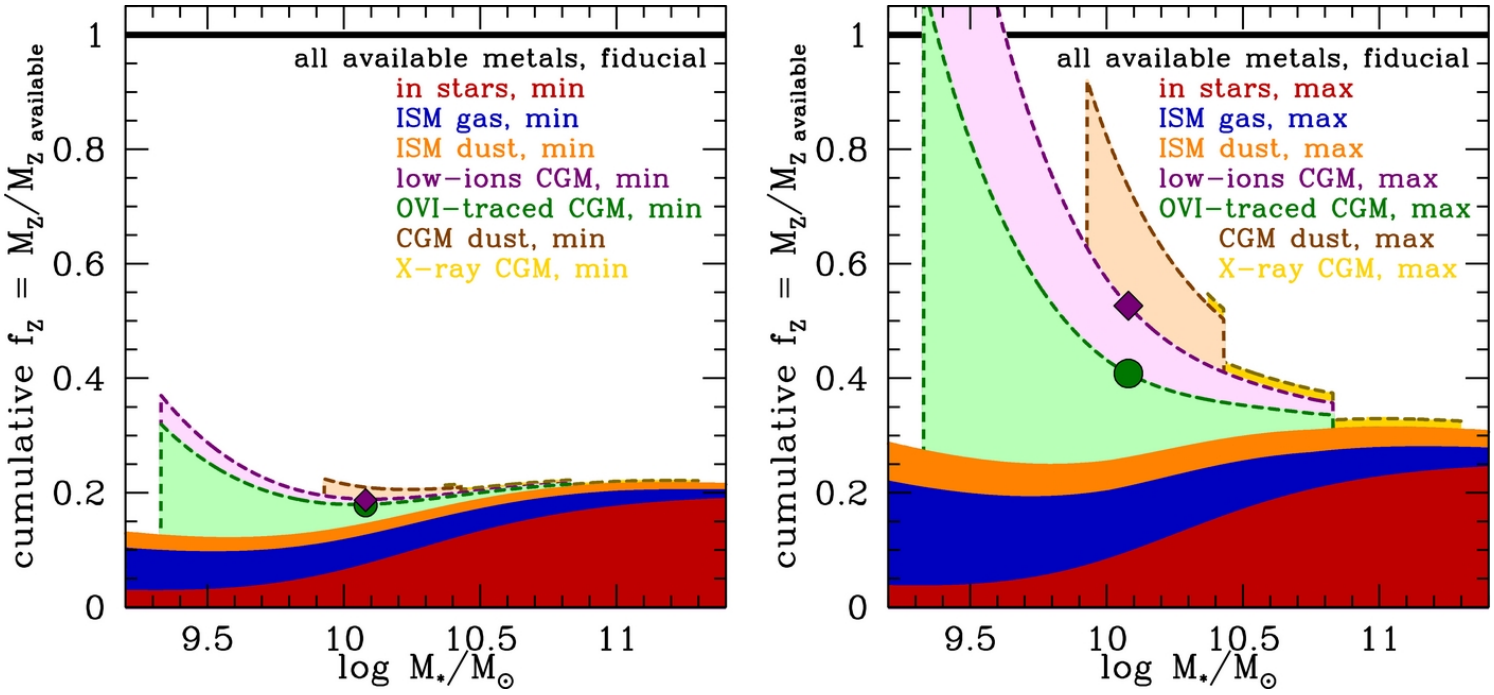
A Sloan sized view of the same diagnostic diagram:



Tremonti+ 2004

Oh, by the way…

Something that doesn't seem to fit into the big picture



Peeples+ 2014

Returning to Apertif

I envision a Sloanish sized sample of star forming galaxies with resolved HI observations.

That's a lot of galaxies with rotation curves and HI distributions.

A lot of those galaxies will have Califa or MANGA observations (resolved star formation rates and abundance gradients).

So, plenty of effective yield measurements.

But, to me, the interesting bit is not just the mean trends, but the dispersions in the trends and the nature of the outliers. (After all, studying galaxies as a function of environment is the most interesting of all questions –JvG.)

Summary

I look forward to the Apertif HI surveys.

I think that the y_{eff} vs. V_{rot} or M_{baryon}
Could be interesting diagnostic diagrams.