Analyzing Systematic Trends in Cosmic SFR Evolution

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Introduction

The diffuse supernovae neutrino background (DSNB) is the flux of antineutrinos and neutrinos produced by core-collapse supernovae explosions (CCSNe), and CCSNe occur at the end of a massive star's life. In order to learn more about rate at which CCSNe happen, physicists can study the birth rate since these two rates are nearly the same when looking from the cosmology timescale. The birth rate is known as the star formation rate (SFR) in the units of $M_{\odot}$ yr^{-1} Mpc^{-3}. Studying the SFR can help predict where to detect neutrinos in the DSNB, in which can help uncover details of many physics and astrophysics phenomena such as the cosmic history of stellar birth and death, production of chemical elements essential to life, and provide more information on neutron stars and blackholes.

Fig. 1 *- SN1987A Around 20 neutrinos were detected in 1978 from Earth of nearby SN.*

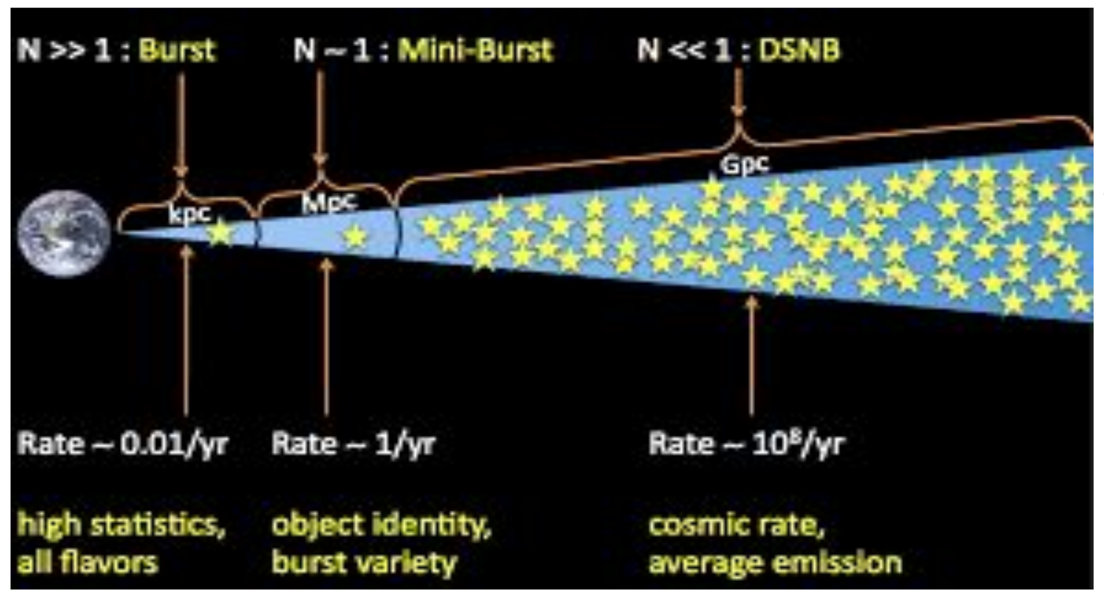

Fig. 2 *- In order to detect more neutrinos physicists have to look further into the universe because SN explosions happen at a greater rate. This requires very large and no background detectors.*

Results

To study systematic trends in a more detailed perspective, the data was split into three different categories; extinction methods, types of indicators, and initial mass function (IMF). The data was also rated gold or silver depending on the usage of what we considered the standard dust extinction method, Kennicutt (1998), and initial mass function (IMF), Salpeter (1955). In all of the plots, we consider measurements at z=0 to be an anchor measurement and it is useful because it's an easy measurement to take since it is at such a low redshift but there aren't enough nearby galaxies to get data from. On each of the plots is also plotted a parametric function from Hopkins and Beacom (2006) (HB06), in which we used as a comparison tool from older data to current.

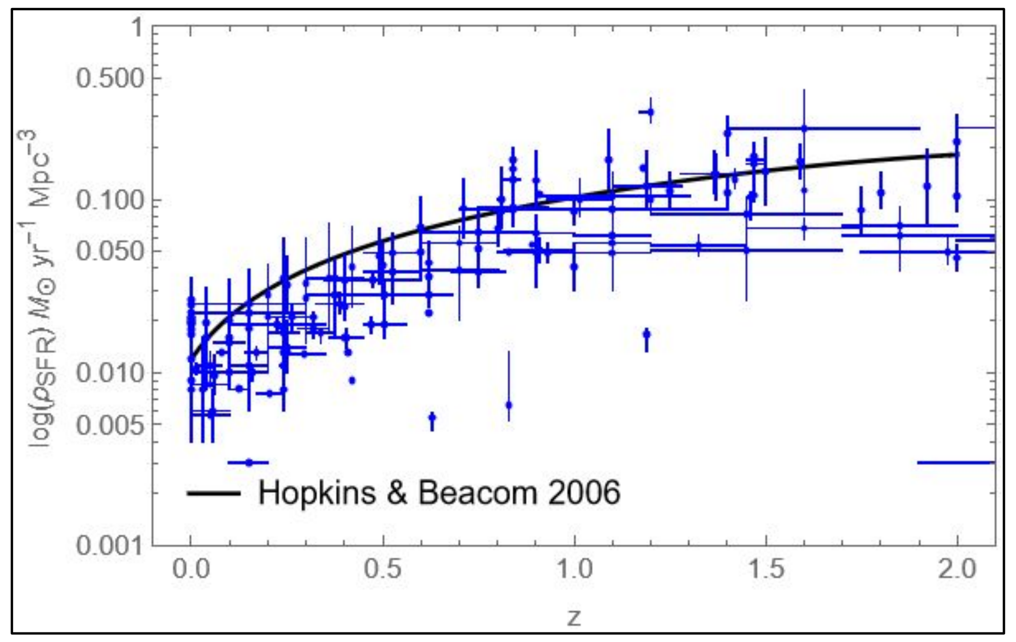

Fig. 3 *- All the data from the database uncategorized. We can see that the current data is systematically lower then HB06.*

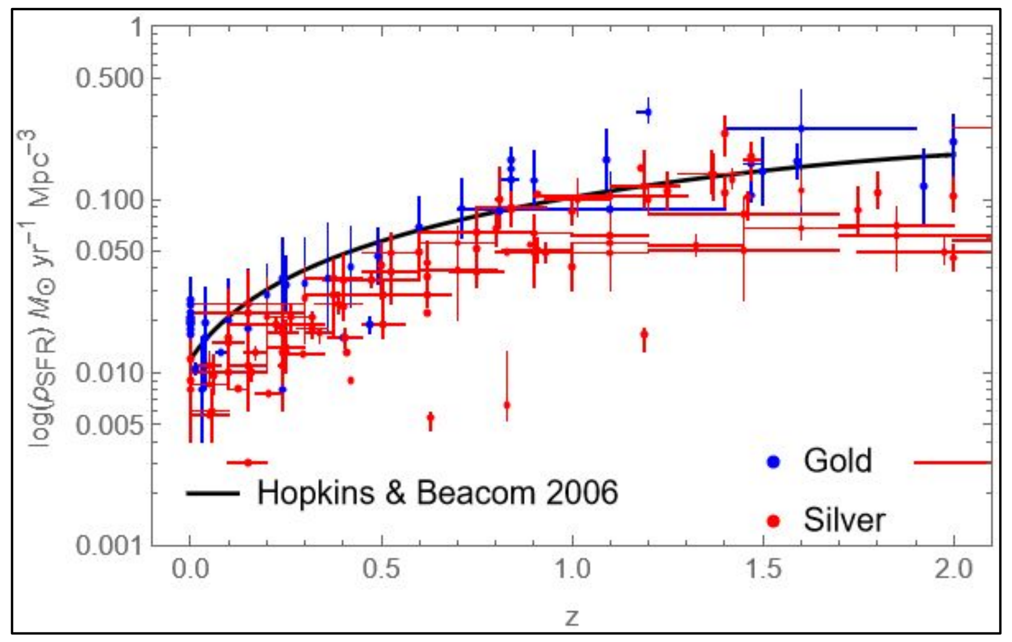

Fig. 7 *- Gold and Silber Data Samples, gold is systematically consistent with HB06.*

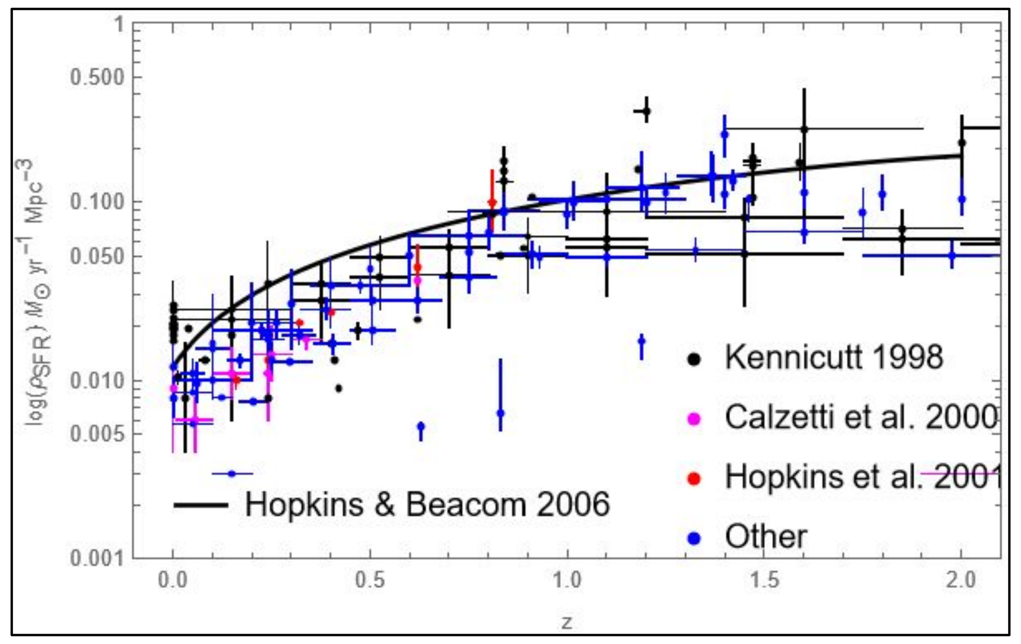

Fig. 4 *- Dust Extinction Log Plot, the standard method (black dots) seems to be most consistent with HB06.*

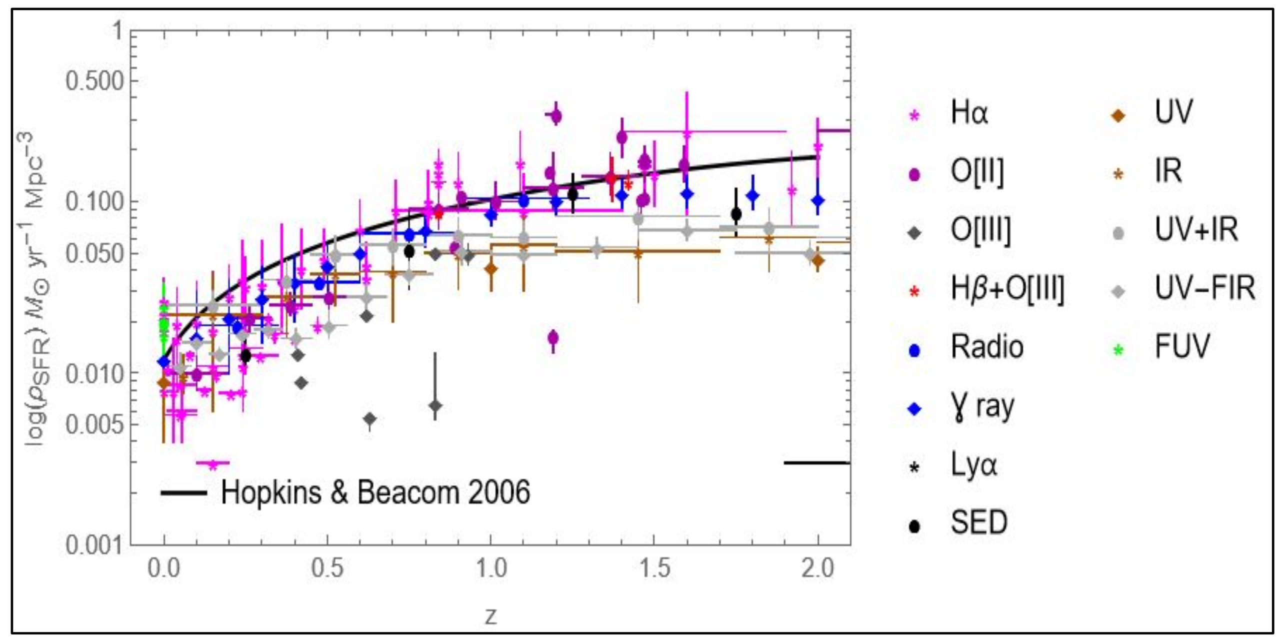

Fig. 5 *- Indicator Log Plot, there is no standard indicator chosen but it seems Hα is more consistent with HB06 as well does it have the largest error bars.*

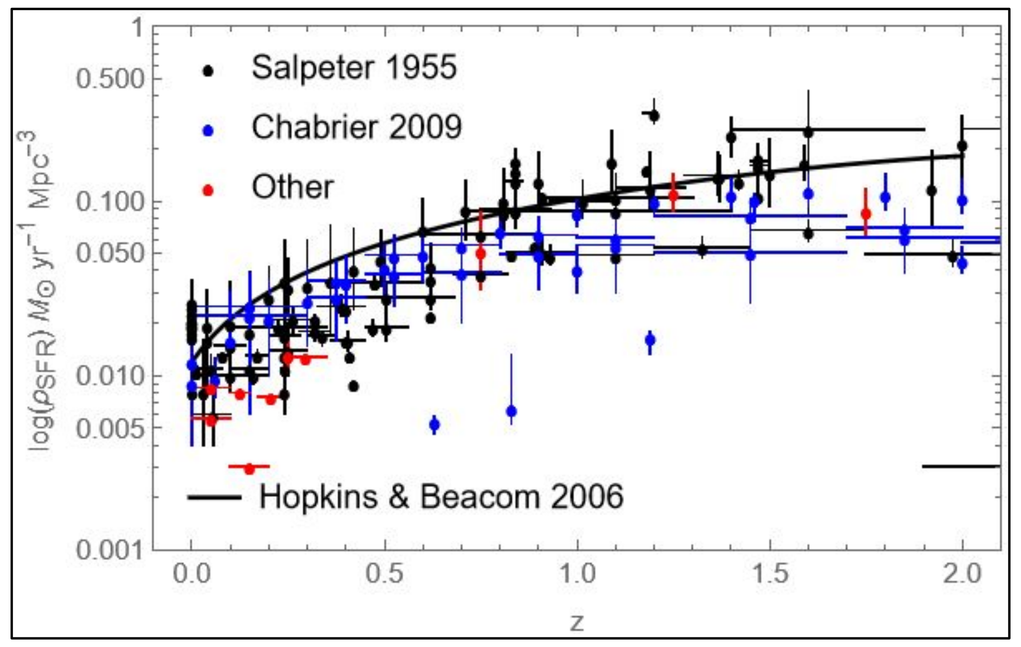

Fig. 6 *- IMF Log Plot, Salpeter (1955) and Chabrier (2009) are not much different systematically.*

Methods

Hyperlink	x	Redshift			SFR	Stat. Err.		Sys. Err.	
		z	min	max	(Msun*yr^-1*Mpc^-3)	(+) δ	(-)δ	(+) δ	(-) δ
Blanc et al. 2011	x	z	1.90	2.80	0.003	0.002	0.001		
Cai-Na Hao et al. 2018	x	2.23	2.20	2.26	0.724	0.897	0.401		
Coughlin et al. 2018	x	0.62			0.043	0.009	0.007	0.011	0.009
Geach at al 2008		2.23			0.170	0.160	0.090		
Ly et al. 2007		z	0.07	0.09	0.013				

Table 1 *- Database*
This is the first 5 sources from the database, the full database can be located with the link below.

In order to study the SFR we created a database of around 200 current SFRs at low redshifts (z) to quantify and study their systematic trends. As seen in table 1 and 2, information such as redshift, SFR density measurements, statistical and systematic errors, active galactic nuclei (AGN) contamination, type of indicator, extinction methods, standard calibration methods and cosmology assumptions were recorded along with the hyperlink to each of the articles.

AGN		Indicator	Extinction Method		Std. Calibration		Cosmology Assump.		
(+) δ	(-) δ				Metalicity	IMF	Ho	Ωm	ΩΛ
N		Lyα	Y host, Calzetti et al. 2000	Y host, Calzetti et al. 2000	Y	Y	70	0.3	0.7
N		Lyα	Y host, Calzetti et al. 2000	Y host, Calzetti et al. 2000	Y	Y	70	0.3	0.7
Y		Hα	Y host, Hopkins et al. 2001	Y host, Hopkins et al. 2001	Y	Y	71	0.27	0.73
Y		Hα	Y host, Kennicutt 1998	Y host, Kennicutt 1998	Y	Y	70	0.3	0.7
N		Hα	Y host, Kennicutt 1998	Y host, Kennicutt 1998	Y	Y	70	0.3	0.7

Table 2 *- Database*
The database has 46 different sources total and is all current data only going as far back at 2006.

Conclusion/Future Work

New SFR density measurements support HB06 as long as the standard set for gold is used. Since the IMF differences are very little and a range of indicators are represented in the gold sample, that means the SFR measurements are more heavily affected by the dust extinction corrections used by the authors.

In the future, continuing to grow our database is imperative to achieving the goal of this project. We would also like to convert all of the Chabrier IMF to Salpeter IMF for better a comparison on the log plot. In Fig. 7 we will eventually add a bronze category based on systematic differences between extinction methods.

Full database: https://docs.google.com/spreadsheets/d/1g52NqaG4yrjwQuzDvNbtl3IHKWea_A-tUt2FNr7zSG0/edit?usp=sharing
Larger view of the plots: https://docs.google.com/document/d/12fiucGBfFGhAwd2g9nqS7rvKEP9OfjBCJQZKV_YWQxM/edit?usp=sharing
References: https://docs.google.com/document/d/1GIZDDJ83-X314slfxI7GD1kp0TzuyCcqkvmqdln9zF0/edit?usp=sharing