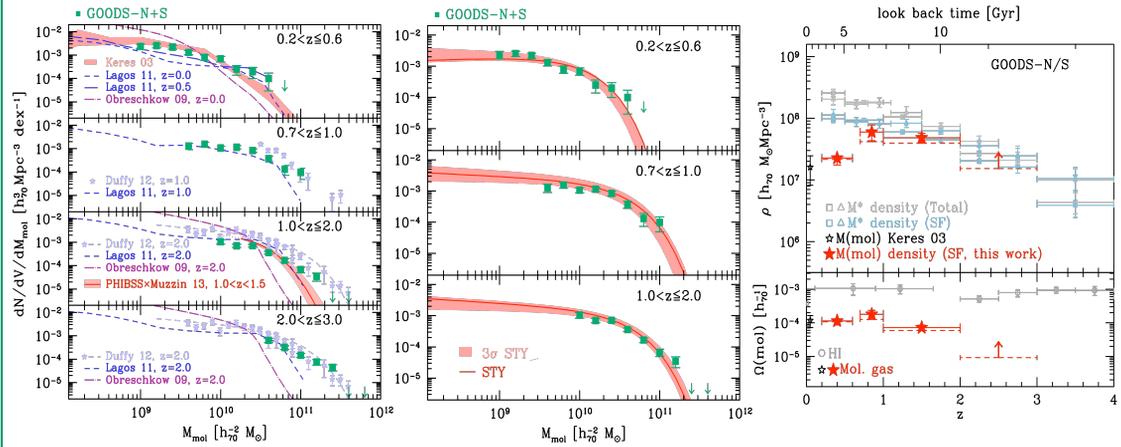


by *Stefano Berta (MPE), the PEP Team, et al.*

Abstract. We use deep far-infrared data from the PEP/GOODS-*Herschel* surveys and rest frame ultraviolet photometry to study the evolution of the molecular gas mass function of normal star forming galaxies. Computing the molecular gas mass, M_{mol} , by scaling star formation rates (SFR) through depletion timescales (Tacconi et al. 2013; Saintonge et al. 2012), or combining IR luminosity and obscuration properties as in Nordon et al. (2013), we obtain M_{mol} for roughly 700, $z=0.2-3.0$ galaxies near the star forming “main sequence”. An alternative way to derive M_{mol} is based on the knowledge of dust masses: we test this approach and its performance using *Herschel* bands.



Molecular gas mass function (based on the $1/V_a$ estimate, green squares) compared to literature data (Keres et al., 2003) and models (Obreschcow et al. 2009, Lagos et al. 2011, Duffy et al. 2012).

The red line and shaded area at $z=1.0-2.0$ are obtained scaling the Muzzin et al. (2013) stellar mass function using molecular gas fractions by Tacconi et al. (2013). Note also the related approach by Sargent et al. (2014).

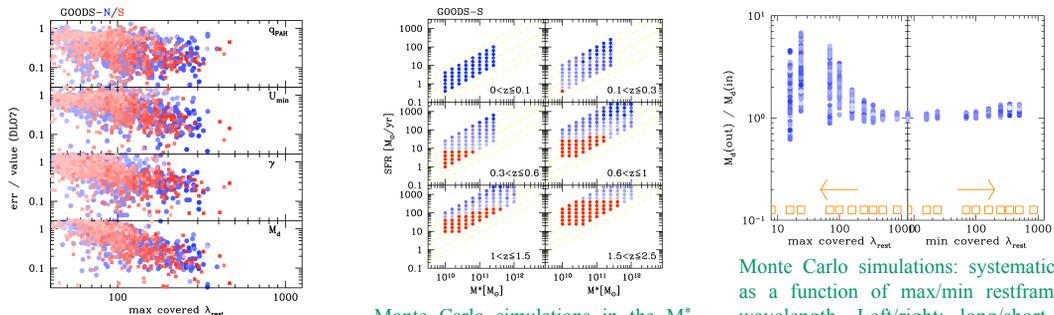
Parametric estimation of the mass function adopting a Schechter form (red lines and shaded areas), obtained via the Sandage, Tammann & Yahil (1979, STY) approach.

The Schechter M^* parameter increases by a factor >3 between $z=0.4$ and 0.8 , and flattens at $z>1$. It resembles the evolution of the IR luminosity function of star forming galaxies, and reflects the link between SFR and M_{mol} (Berta et al. 2013).

The molecular gas mass density increases by a factor of ~ 4 from $z=0$ to $z=1$ and then remains almost constant up to $z \sim 2$. For reference we plot also the stellar mass density up to $z=4$. The different trends reflect the growth of gas fractions with redshift (e.g. Tacconi et al. 2013, Saintonge et al. 2012).

The density parameter $\Omega_{\text{mol}}(z) = \rho_{\text{mol}}(z) / \rho_{\text{c}}(z)$ peaks at $z \sim 1.0$.

The M_{mol} of galaxies can be also derived by scaling dust masses using locally-calibrated relations, such as the dependence of the gas/dust mass ratio on metallicity. Using SED fitting with Draine & Li (2007, DL07) models and *Monte Carlo* simulations we study the accuracy on M_{dust} allowed by *Spitzer+Herschel* bands (24-500 μm) and its systematics (Berta et al., in prep.).



Uncertainties on DL07 parameters and M_{dust} from SED fitting, derived for real galaxies in the GOODS-N/S fields.

Monte Carlo simulations in the M^* -SFR- z space. The color code reflects the relative M_{dust} error obtainable with SED fitting at the depth of GOODS-S (darker=smaller error; red $>33\%$).

Monte Carlo simulations: systematics as a function of max/min restframe wavelength. Left/right: long/short- λ bands are progressively removed. Each column of points relates to MC realizations with all long/short-wards bands missing.

A limited SED coverage, mainly due to sensitivity limitations combined to redshift, can cause important over/under-estimations of M_{dust} . The availability of $\lambda_{\text{rest}} \geq 200 \mu\text{m}$ datapoints guarantees M_{dust} estimates with $\leq 33\%$ uncertainties. A poorer coverage results in more severe errors. Sub-mm data are the key to obtain reliable M_{dust} measurements at high- z and thus to build the M_{mol} mass function based on far-IR SED fitting (modulo the underlying dust/gas scaling relations).

References:

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For further information, please see Berta et al. (2013, and in prep.) or contact: berta@mpe.mpg.de