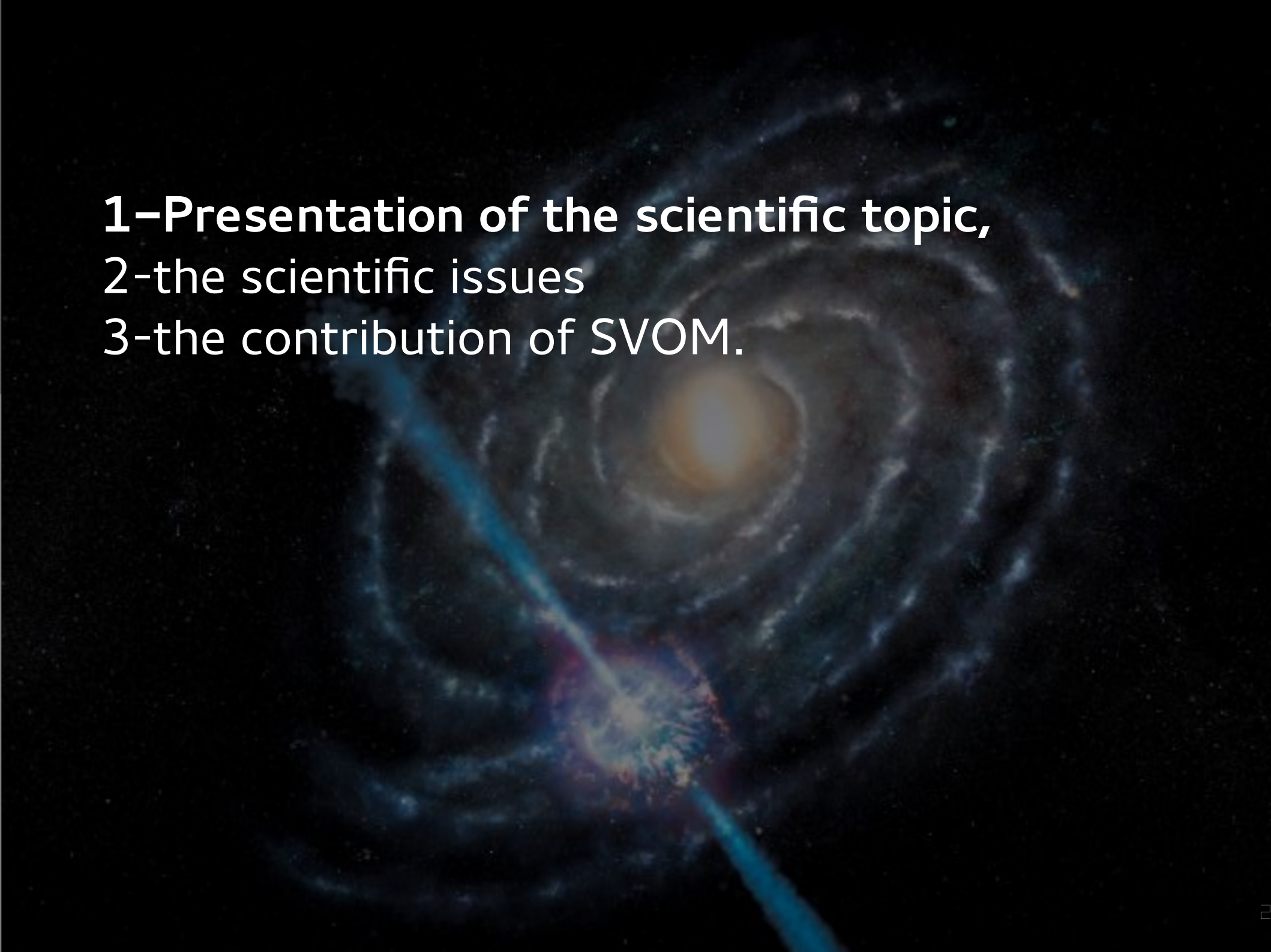
GRBs to study the evolution of star formation

(GRBs and Star Formation Rate)

Coordinators :
S. BOISSIER
F.Y. WANG



1–Presentation of the scientific topic,
2-the scientific issues
3-the contribution of SVOM.

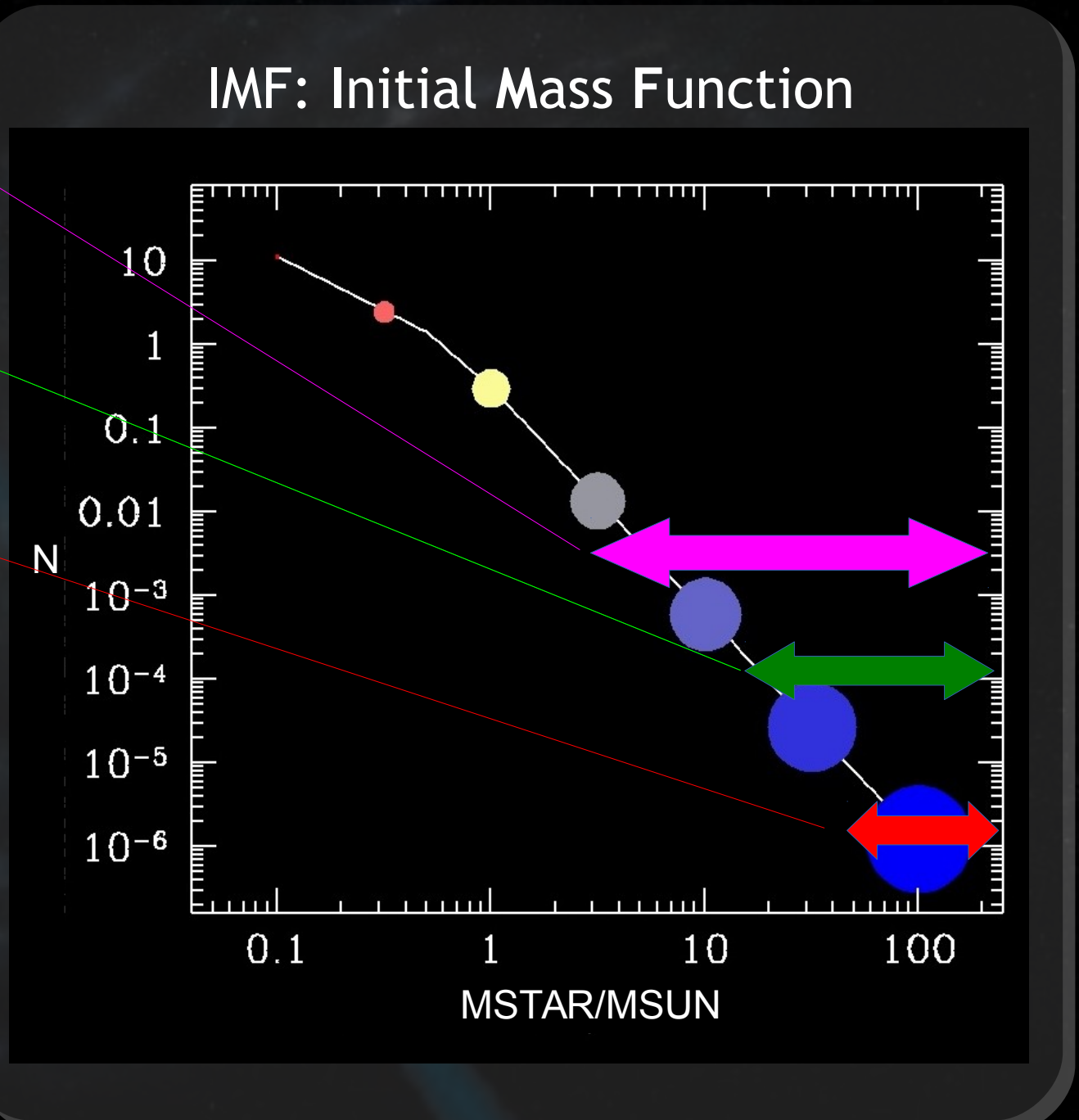
Long GRBs comes from massive stars

UV emission

H-alpha emission

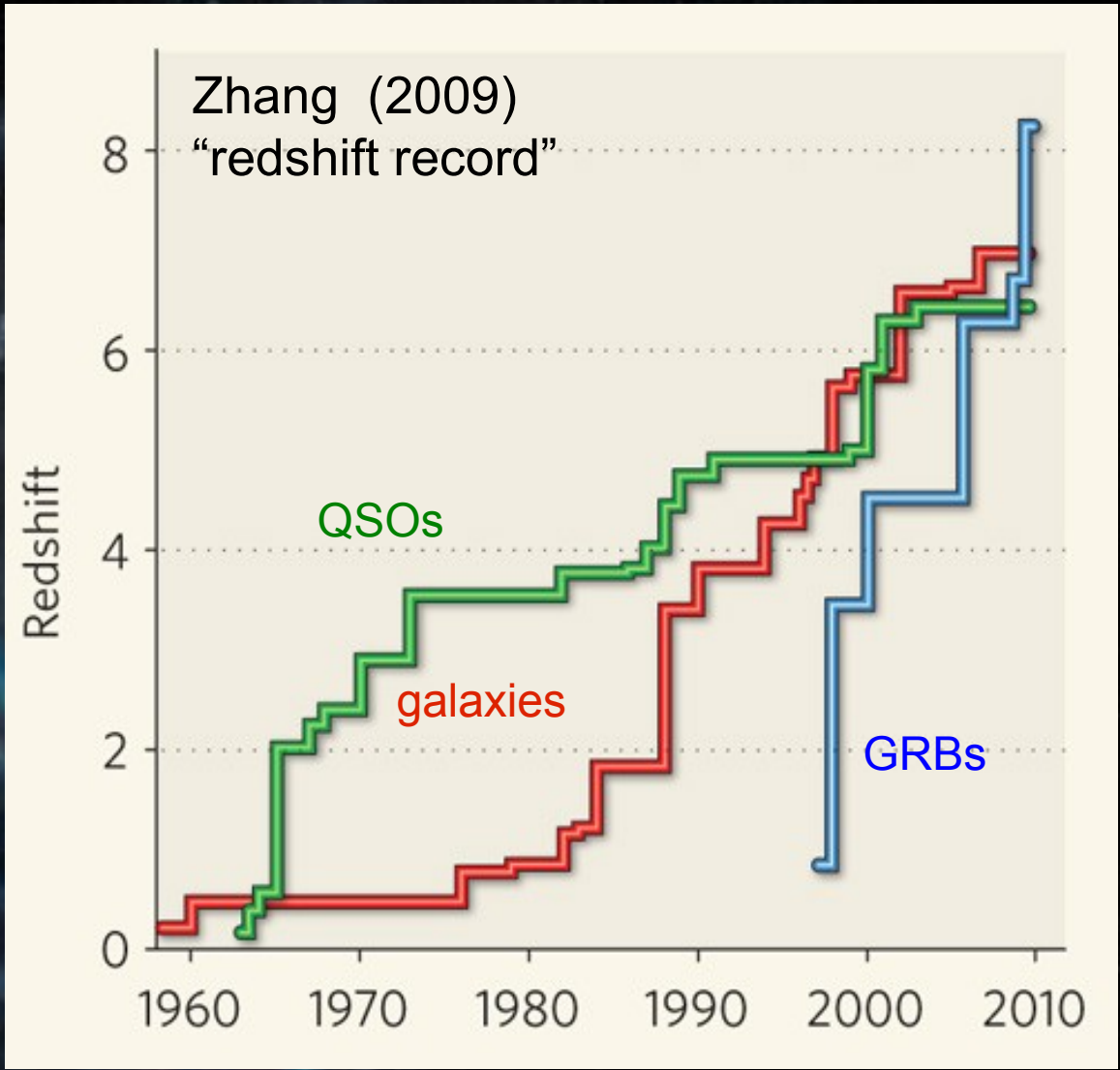
LGRB?

Long GRBs rate can be used to mesure the Star Formation Rate.

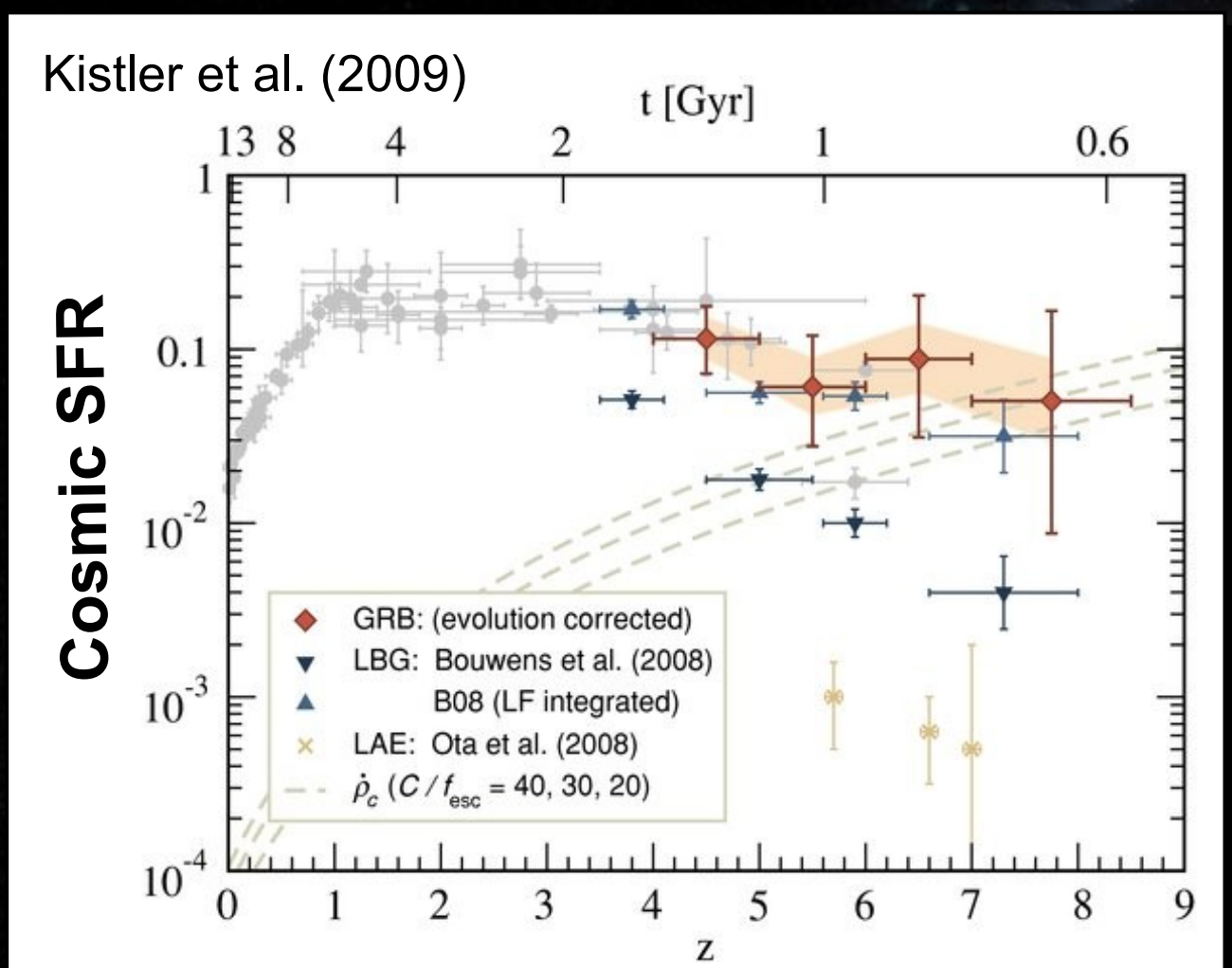


GRBs probes the first ages of galaxy assembly.

GRBs allow to detect very high redshift objects.



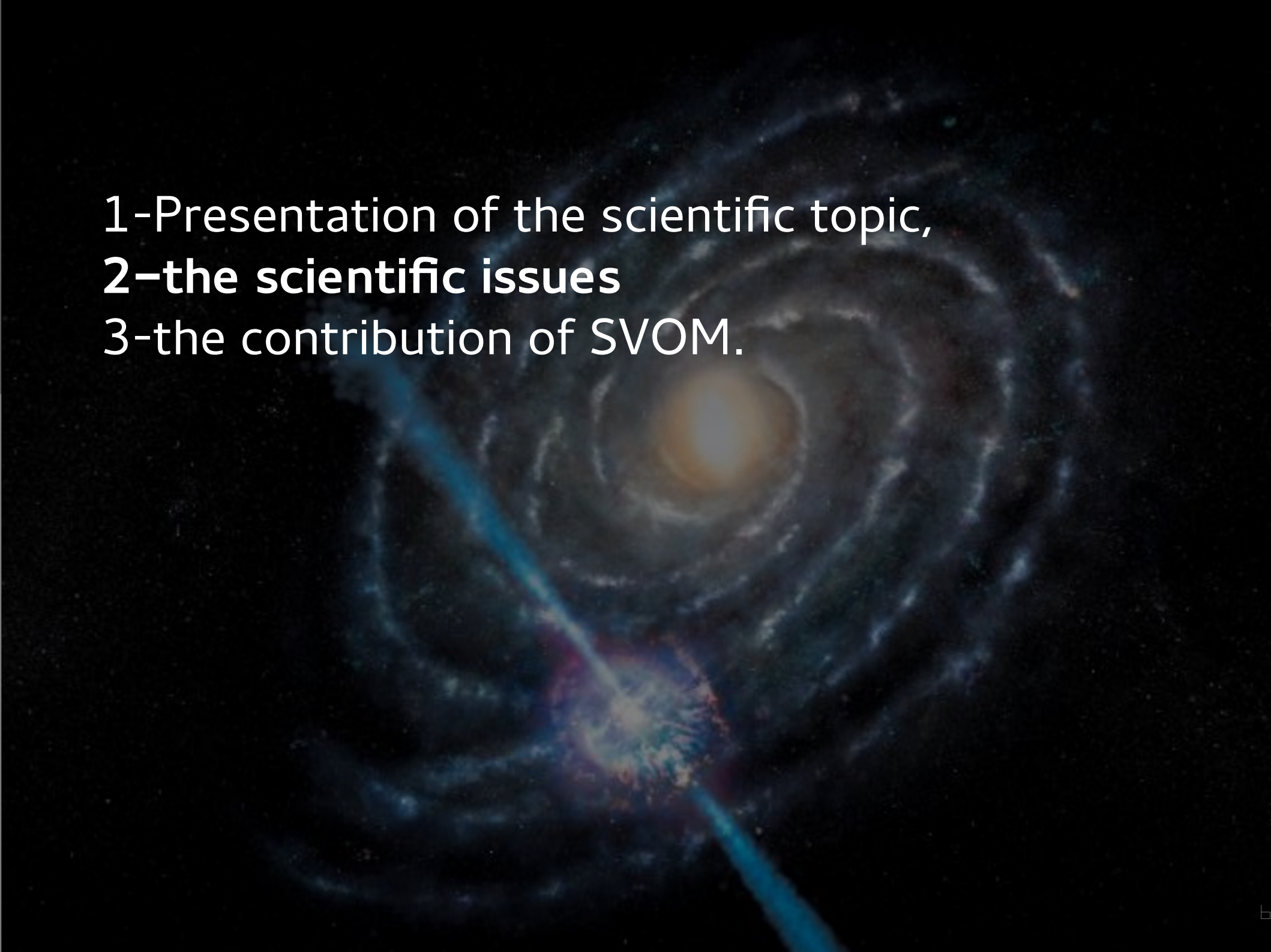
GRBs probes the first ages of galaxy assembly.



one example of Madau plot (>57 000 google hits)

Madau et al. (1996), (>1 700 citations)

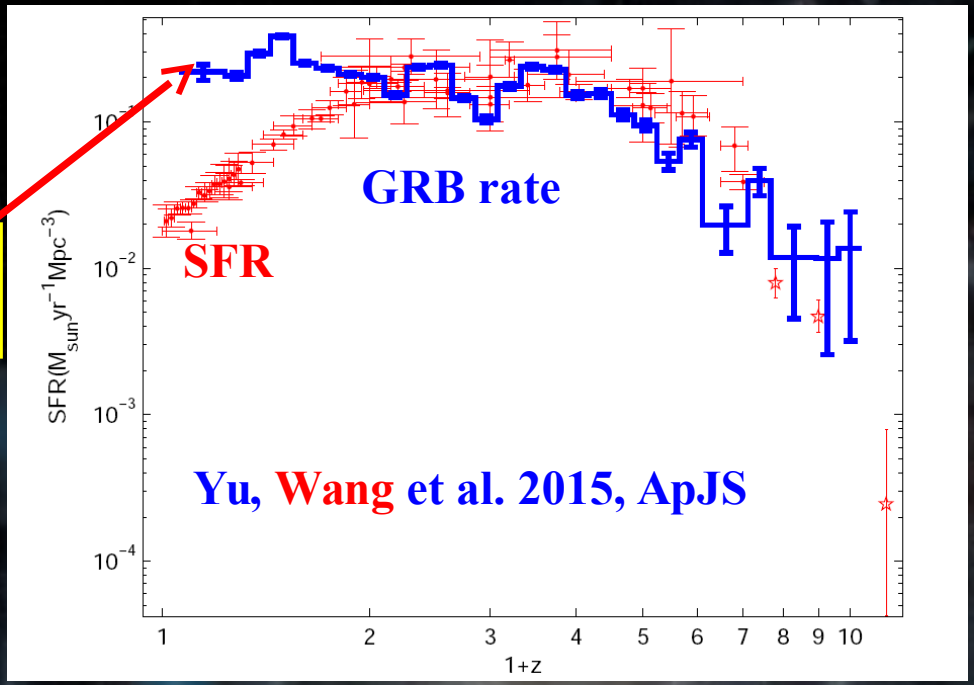
LGRBs offer us a star formation tracer in the early universe.



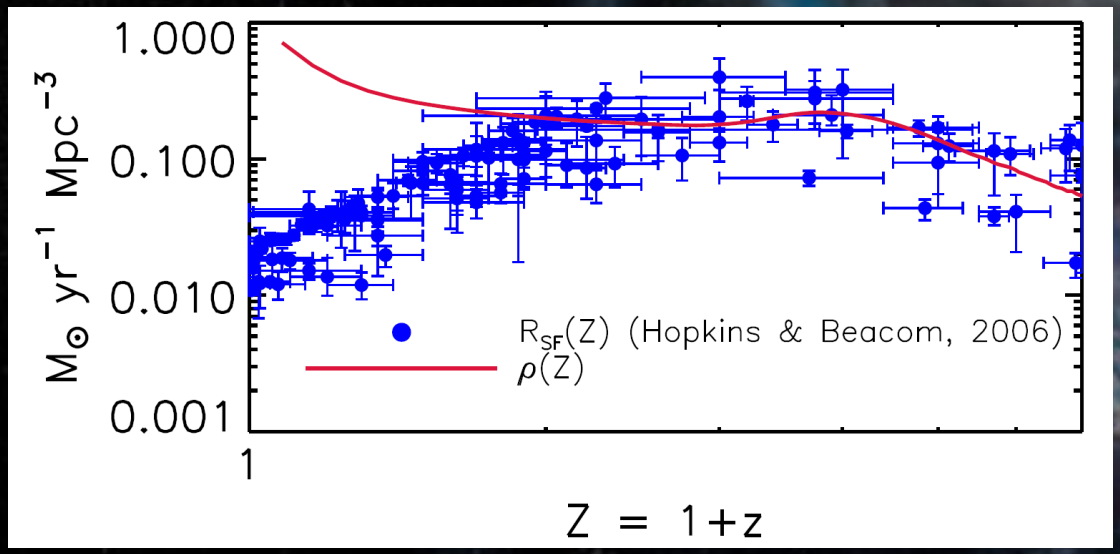
1-Presentation of the scientific topic,
2-the scientific issues
3-the contribution of SVOM.

Low-redshift excess?

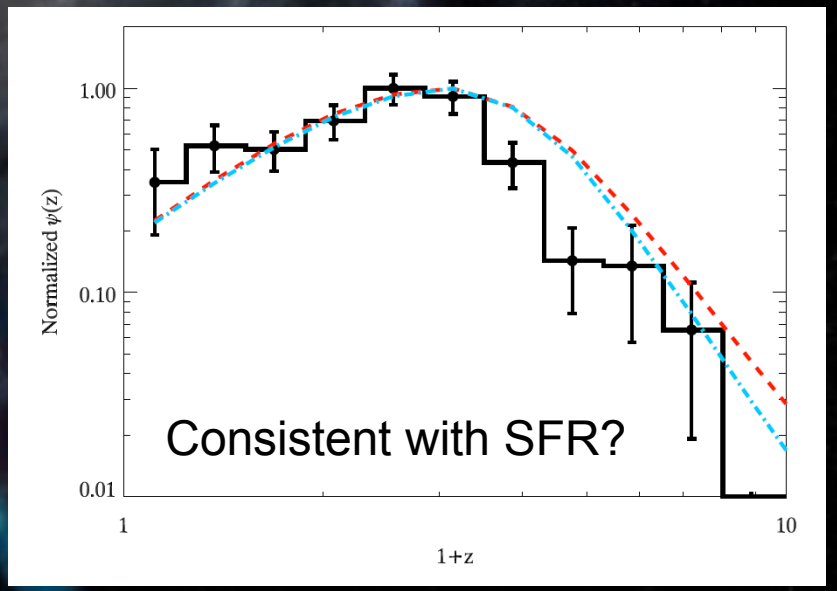
The rate of GRB is larger than SFR at z<1!



Lynden-Bell's c⁻ method (Lynden-Bell 1971).



Petrosian et al. 2015, ApJ

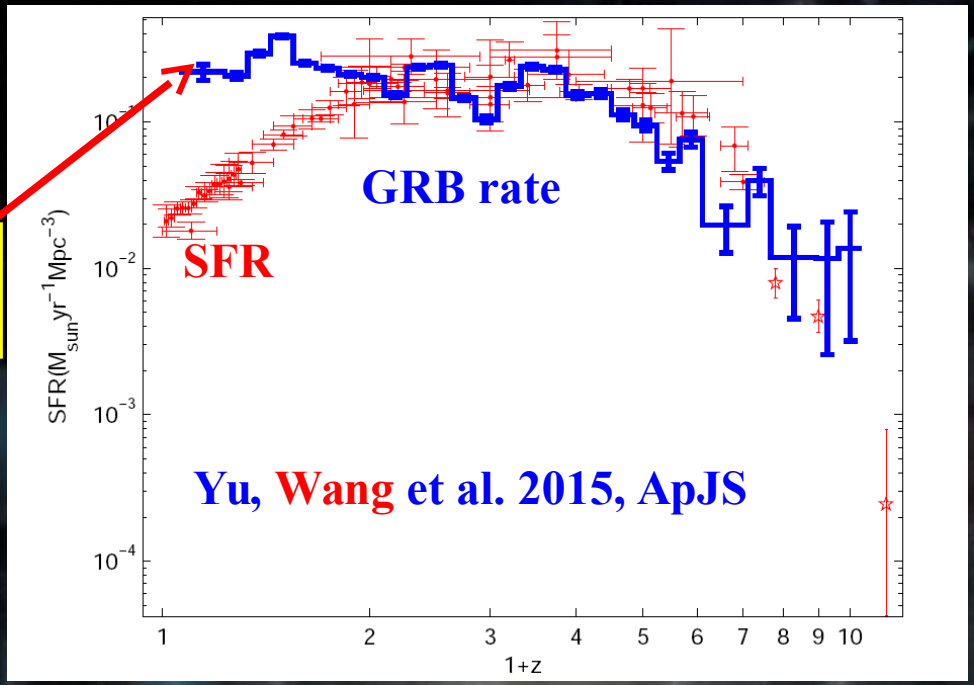


Pescalli et al. 2016, A&A

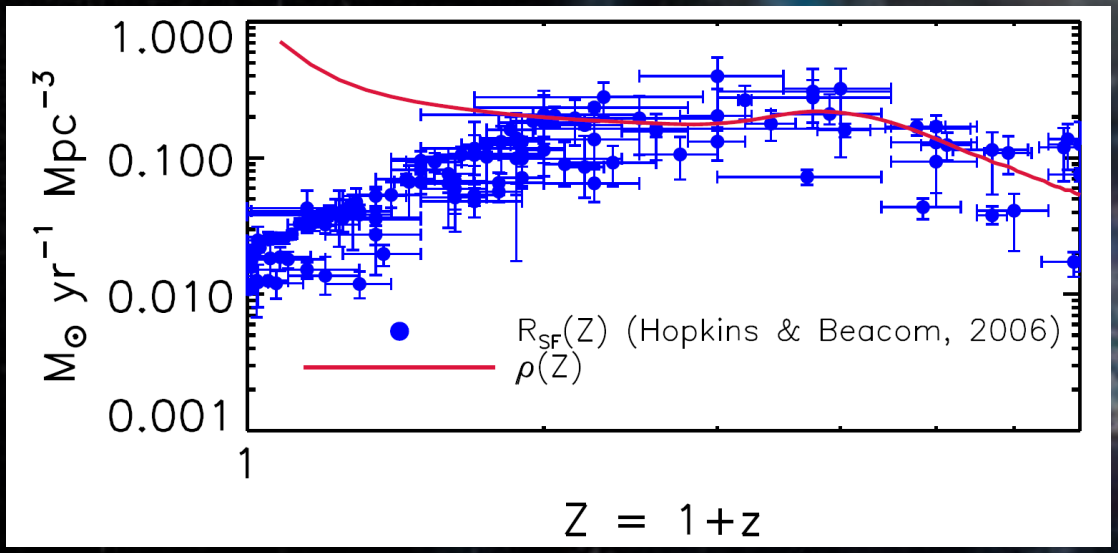
« We know the GRB Rate does not follow the Cosmic SFR »
(Frédéric Daigne)

Low-redshift excess?

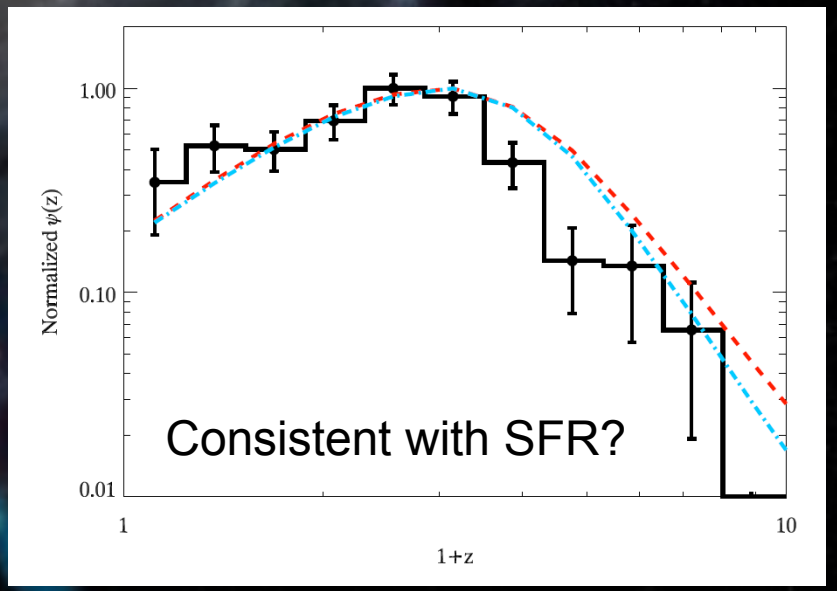
The rate of GRB is larger than SFR at z<1!



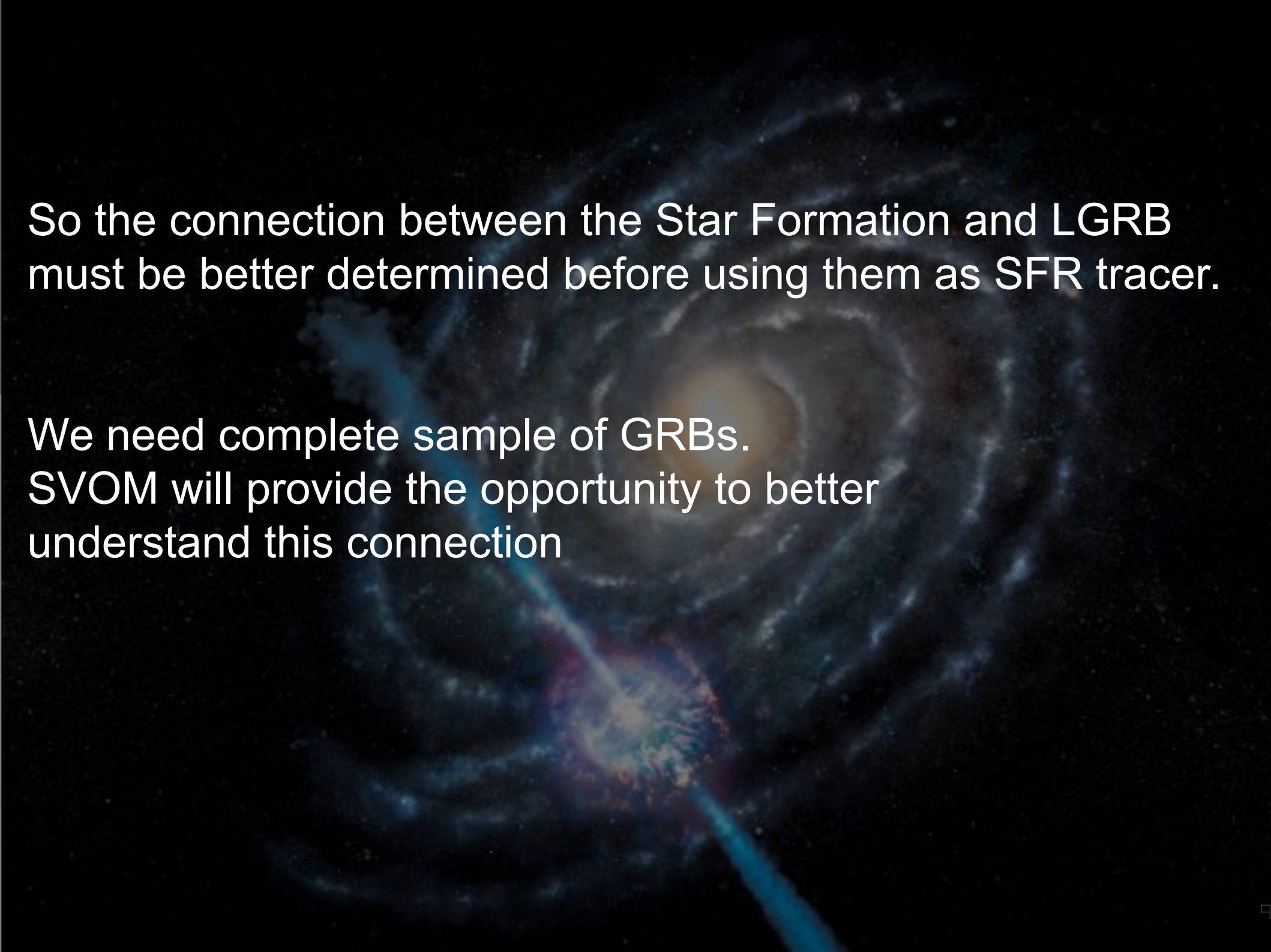
Lynden-Bell's c⁻ method (Lynden-Bell 1971).



Petrosian et al. 2015, ApJ



Pescalli et al. 2016, A&A



So the connection between the Star Formation and LGRB must be better determined before using them as SFR tracer.

We need complete sample of GRBs.
SVOM will provide the opportunity to better understand this connection

In a perfect universe, massive stars would create LGRBs with a constant efficiency :

$$\dot{N} = \epsilon \times \dot{\rho}_*(z)$$

LGRBs rate

« efficiency »

Star formation Rate density

But in this universe, astronomers have to work a bit more.

Our motivation is to measure the evolution of the cosmic SFR from LGRBs rate. Thus, we first need :

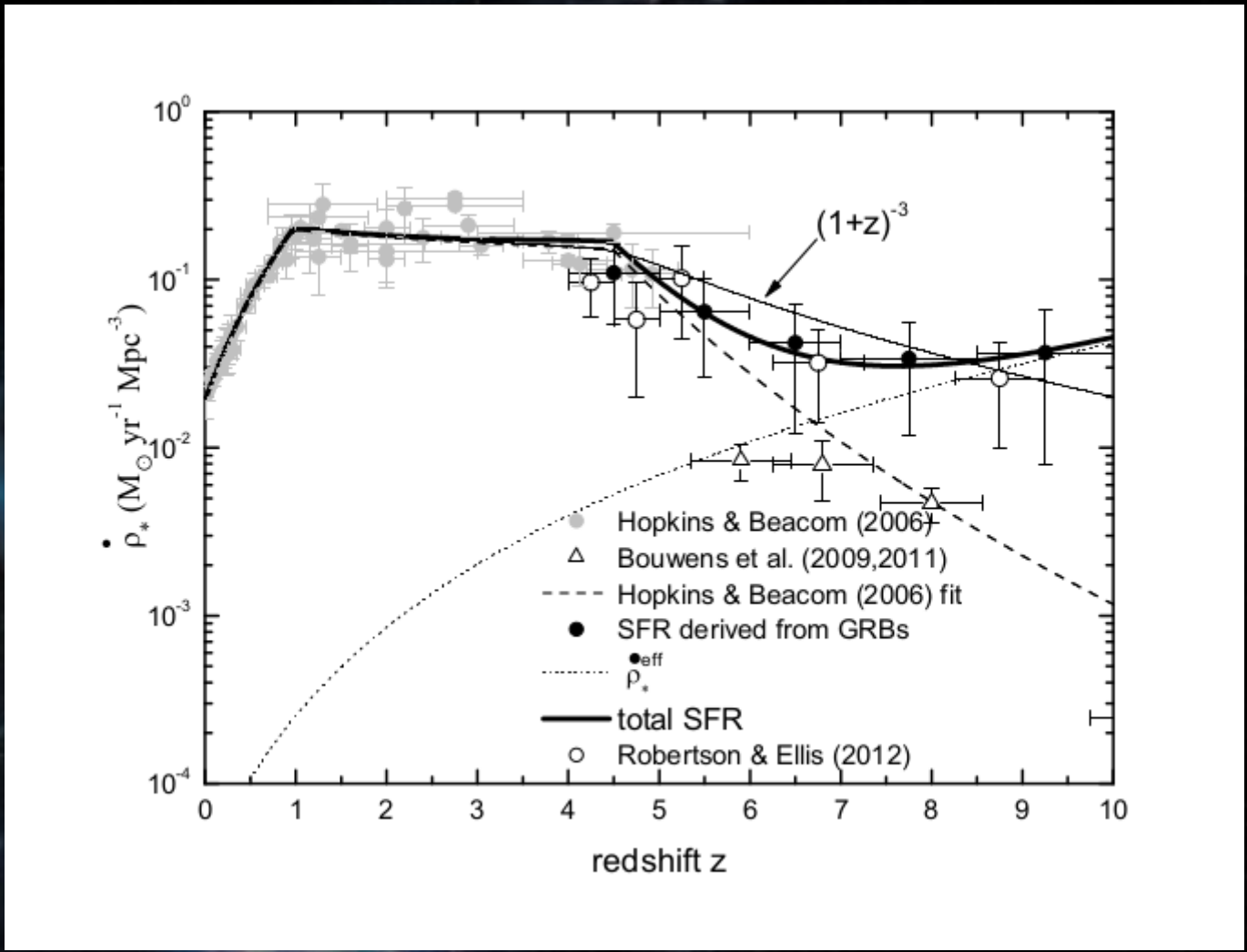
- to understand how the efficiency evolves with redshift
- to understand how the efficiency depends on physics

Method #1 : measuring the redshift evolution of the efficiency

Assuming the efficiency varies with redshift, these parameters can be fitted at low z (<4)

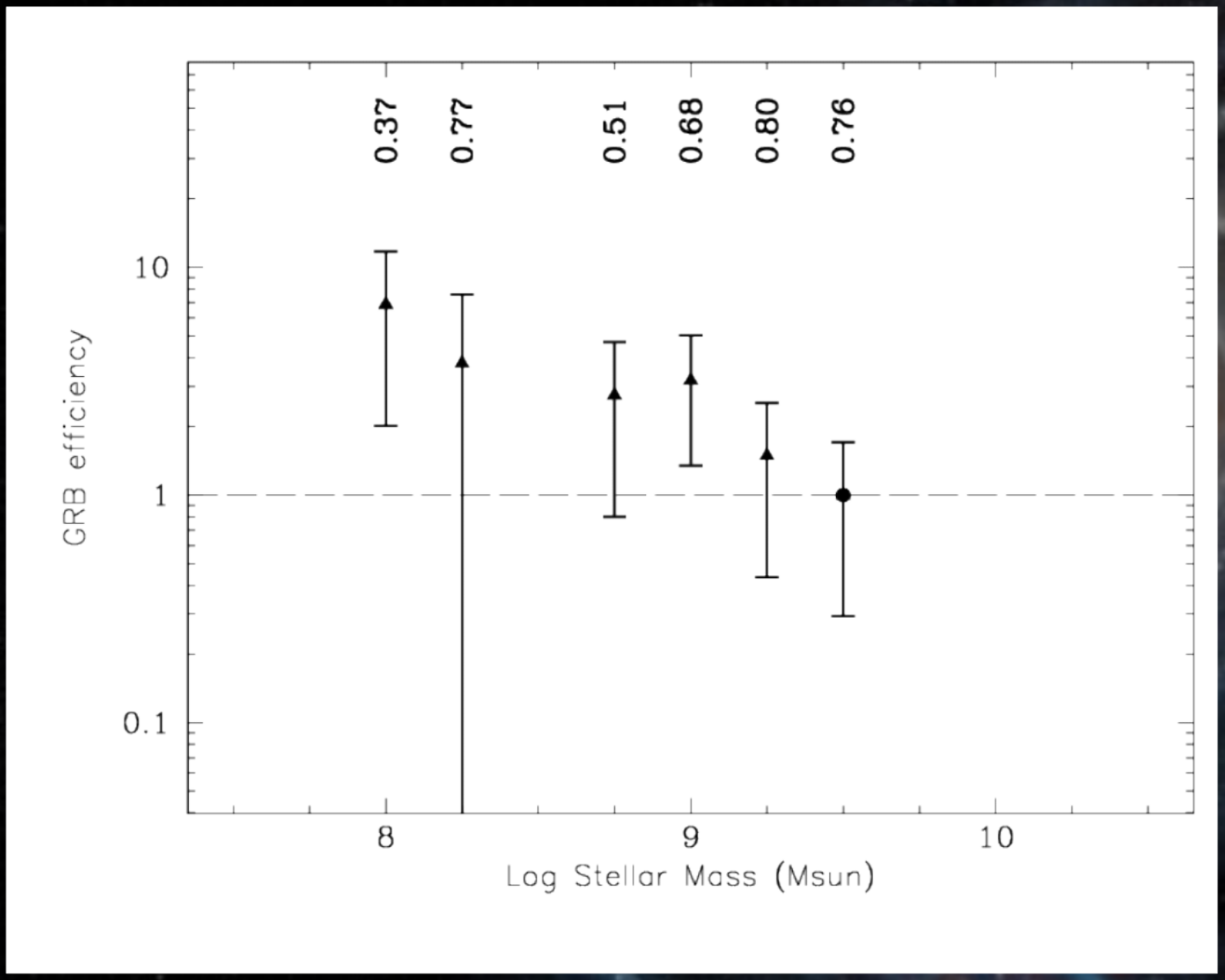
$$\epsilon = \epsilon_0 (1+z)^{\delta}.$$

Then, folding in all redshift variations, one can derive the cosmic SFR up to very high redsfhit



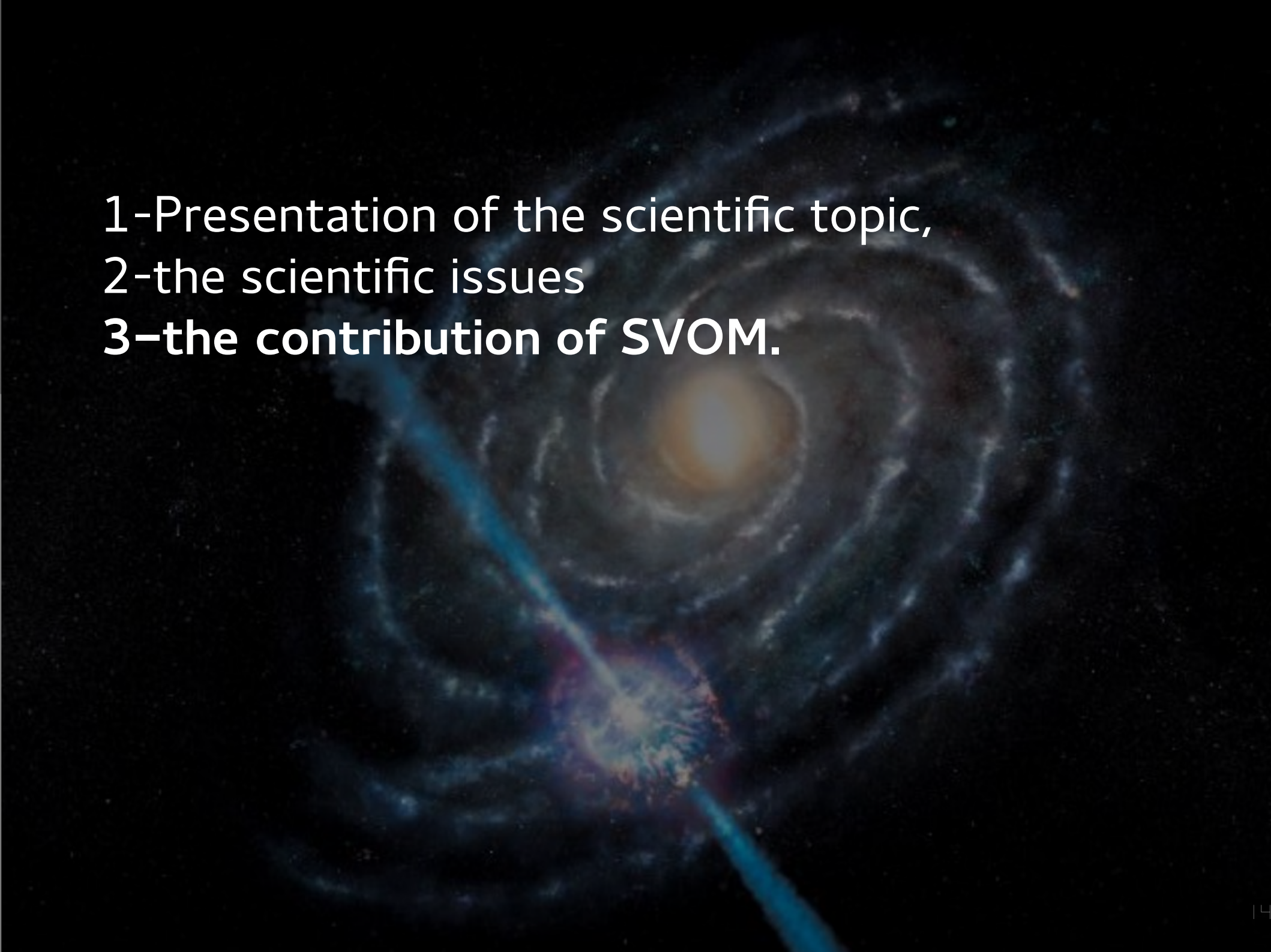
Adapted from Wang 2013

Method #2 : measuring physical effects on the efficiency



Comparing complete sample of « normal » galaxies and LGRBs hosts, we can deduce how the efficiency varies with e.g. SFR, M*.

From Vergani 2014
See also Boissier 2013.

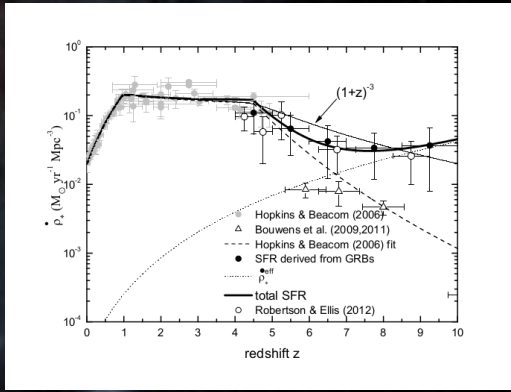

1-Presentation of the scientific topic,
2-the scientific issues
3–the contribution of SVOM.

The contribution of SVOM :

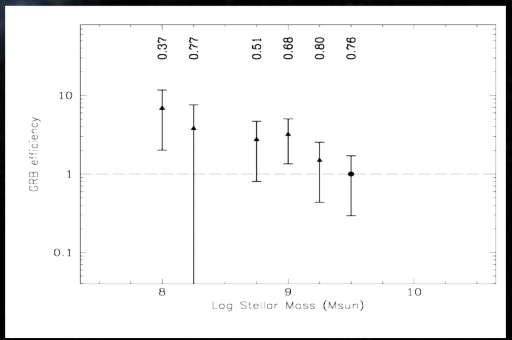
- SVOM will allow us to better constrain δ and other parameters from the cumulative redshift distribution than with the current Swift sample (Wei et al. 2016).

$$\epsilon = \epsilon_0 (1+z)^{\delta}.$$

- SVOM will allow us to increase the statistics at redshift larger than 5 :
  8 GRBs currently,
  15 expected in the nominal mission



- Constraints on the variation of the efficiency with stellar mass (or SFR,...) will be possible for larger complete samples than today, less affected by biases owing to the rapid follow-up, including in near-infrared



Scientific requirements on SVOM

- Permit the detection of all know types of GRBs (>200), with a spec care on high-z GRBs and low-z sub-luminous GRBs
- Provide fast, reliable and accurate GRB positions
- Measure the broadband spectral shape of the prompt emission (from visible to MeV)
- Measure the temporal properties of the prompt emission
- Quickly identify the afterglows of detected GRBs, including those which are highly redshifted (z>6)
- Quickly provide (sub-) arcsec positions of detected afterglows
- Quickly provide redshift indicators of detected GRBs