Studying the progenitors of long GRBs through their nearby environments

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Studying GRB progenitors through their hosts

Adapted from Graham&Fruchter, 2013
(see Krühler+15)

Fruchter+06

Adapted from Graham&Fruchter, 2013
(see Krühler+15)
MUSE data cube contains 90,000 spectra or 3600 images

- 1’ x 1’ field of view
- Wavelength range 4800-9300 Å
- Resolving power 1800-3600 Å
- Small spaxel size 0.2” x 0.2”
Probing the environments of SNe

SN2009md

Use Hα equivalent width to trace stellar age
GRB 980425/SN 1998bw

Closest GRB ever detected at $z=0.0085$
The host galaxy of GRB 980425/SN1998bw

Christensen+08

Krühler, HK, PS+17
A MUSE view of GRB980425/SN1998bw

Dopita et al. (2016) N2S2 diagnostic

GRB 980425/SN1998bw happened in a low-metallicity, star forming region of its host galaxy
Using Hα as tracer of stellar age

Hα equivalent width (EW):
ratio of Hα line flux (young stars) over continuum (old stars)

BPASS
Starburst99
GALEV

Kuncarayakti+16 (see also Leloudas+11, Kuncarayakti+13a,b, 18)

Hα EW traces stellar age, but only if we probe single stellar population
GRB 980425/SN1998bw unlikely to have originated in WR region, but progenitor mass consistent with GRB *collapsar* model
The supernovaless long GRB 111005A

- Second closest long GRB detected at z=0.013
- Massive, dusty host galaxy
The case of GRB 111005A

Oxygen abundance at exposition site of GRB 111005A likely to be $12 + \log(O/H) > 8.6$ (0.8 $Z_{\odot}$)
The case of GRB 111005A

No spaxels around GRB position have $E(B-V) > 1$, but need $E(B-V) > 6$ to extinguish SN in the V band.
GRB111005A: a high-Z GRB formation channel

GRB and host galaxy properties very different to ‘typical’ long GRBs

BPASS12; Eldrige & Stanway (2013)

Tanga, Krühler, PS+18
But is this ok...
Dust Radial Distribution

Assume smooth dust distribution

![Histogram showing the distribution of E(B-V) values with decreasing number of events as E(B-V) increases.]

But what if…?

- $E_{B-V} < 0.8$
- $E_{B-V} > 1$

Decreasing $E_{B-V}$ with $r$
Dust distribution in other galaxies

Determine $E_{B-V}$ radial profile from sample of galaxies from AMUSING with similar stellar mass but range of inclinations.
Distribution of dust radial profiles
Distribution of dust radial profiles
Dependence of $Z_{\text{gas}}$ on resolution

At resolution $>500$ pc, measured $Z_{\text{gas}}$ traces galaxy average metallicity

MUSE offers new opportunity to investigate dependencies of inferred galaxy properties as function of spatial resolution

Niino+15
Dependence of $H_\alpha$ EW on resolution
The measured H$_{\alpha}$ decreases with increasing spatial resolution.
Summary and future work

• IFU observations have the potential of providing a wealth of information on the properties of long GRB progenitors

• But care is required to understand the limitations of the data - in particular spatial resolution

• Future work will use much larger sample of star forming galaxies observed with MUSE to investigate how distribution of \( E_{B-V} \) varies with galaxy inclination as a function of galaxy stellar mass, SFRs, etc…

• Larger-scale analysis of face on, star forming galaxies planned to quantify how measured galaxy properties (\( H_\alpha \) EW, \( Z_{\text{gas}} \), \( E_{B-V} \),…) vary with spatial resolution