Hunting Extreme Emission Line Galaxies using KiDS and 4MOST

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We also had input by Polis Papaderos, Pepe Vilchez, Carolina Kehrig, Kerstin Weis, and Ralf-Jürgen Dettmar.

and from the bachelor, master, and PhD students in the emission line galaxy group at Bochum: Michael Stein, Adam Enders, Djamal Ghandi, Aisha Bachmann, Selim Incirkus, Henning Bergmann, Pascal Vennedey, Alexander Becker, and Marianne Langener.
Extreme emission line galaxies

Serendipitous find at first, e.g. Kewley et al. 2007

Then searches based on broad band colors
At low redshifts (e.g. Brown et al. 2008)
and
high redshift with HST (van de Wel et al. 2011, Maseda et al. 2014)

Nearly in parallel:
identification of a “new class” of galaxies by the volunteers
As part of the “Galaxy Zoo” project: Green Pea Galaxies
(Cardamone et al. 2009)
named after their appearance
In SDSS images

Related objects:
UV bright compact starburst
~ Lyman Break Analogs
(e.g. Overzier et al. 2008)
Extreme equivalent widths

Cardamone et al. 2009
affect broad band colors

Cardamone et al. 2009
Rich spectrum, high ionization

Example SDSS spectrum of a “green dot”
Low Metallicity, highly ionized

Amorin et al. 2010

Izotov et al. 2011
... and compact (and complex)

HST Hα + continuum images
A zoo (or garden) of objects?

EELGs (Kewley et al. 2007; Brown et al. 2008)
Lyman break analogs (e.g. Overzier et al. 2008)
Green Peas (Cardamone et al. 2009, Amorin et al. 2010)
z>1 EELGs (van de Wel et al. 2011)
H-alpha Emitter = HAE (Shim & Chary 2013)
Blue and Purple Marbles (Hidalgo-Gamez et al. 2014)
Blue Nuggets (Tacchella et al. 2016)
Blueberries (Yang et al. 2017)
Little Blue Dots = LBDs (Elmegreen et al. 2017)
Green Pea Analog (Mincheva et al. 2017)
Blackberries (Langener, Bomans et al., in prep)
Green Peas and cohorts (Izotov et al. 2011)

All appear similar, but are they really the same kind of objects?

Veggie name, but not in this class::
Green Beans (Schirmer et al. 2013) → extended emission of AGN
Link to high redshift galaxies

Compact, relatively low metallicity starbursts, moderate to low mass, → excellent proxies for high redshift galaxies
  (e.g. Malhotra et al. 2019)

Good candidates for Lyman continuum leakers
  (e.g. de Barros et al. 2016)

Often Lyman $\alpha$ emitters
  (e.g. Yang et al. 2016)

But also:
catastrophic outliers in photo-z surveys
Many open questions

- are all classes of (non-AGN) EELGs related?
- are all Lyc and Lyα leakers?
- hard radiation field common?
- strong galactic winds or not?
- strong magnetic fields or not?
- special objects of transitory evolution phase?
- what are the progenitors and descendants?
- link to very metal-poor galaxies?

→ need larger samples and larger parameter space (mass, SFR, metallicity, ...
Photometric Surveys

KiDS: $u'\ g'\ r'\ i'$$
ATLAS: $u'\ g'\ r'\ i'\ z'$
DES: $g\ r\ I\ z\ Y$
New search using KiDS

Based only on KiDS-N DR3: 255 sq deg

Wittje, Bomans et al, in prep.
We find peas ...

Wittje, Bomans et al, in prep.
Real green peas

Wittje, Bomans et al, in prep.
A southern sample from KiDS

Already candidates for 3 times the known number of Green Peas going fainter...
Area density

Wittje, Bomans et al, in prep.
Synergy with WAVES

Go deeper for the few spectra of candidate EELGs

Explore higher redshifts with WAVES-Deep?
Link with CRS?

Same pattern possible to exploit ATLAS?
Based on KiDS DR3

Green Peas:
Northern KiDS field: 284 candidates brighter than $i' = 21$
with tight color constraints
684 candidates with slightly looser color constraints and $i' = 22$
each for 255 square deg

→ target density ~ 2.7 objects per square degree,
or 12 per 4MOST pointing
factor 2 more if all other “color dot galaxies” included

→ 4050 (8100) fibers for LRS
1h exposures on average → ~10000 fiber hours
Thank you for your attention.