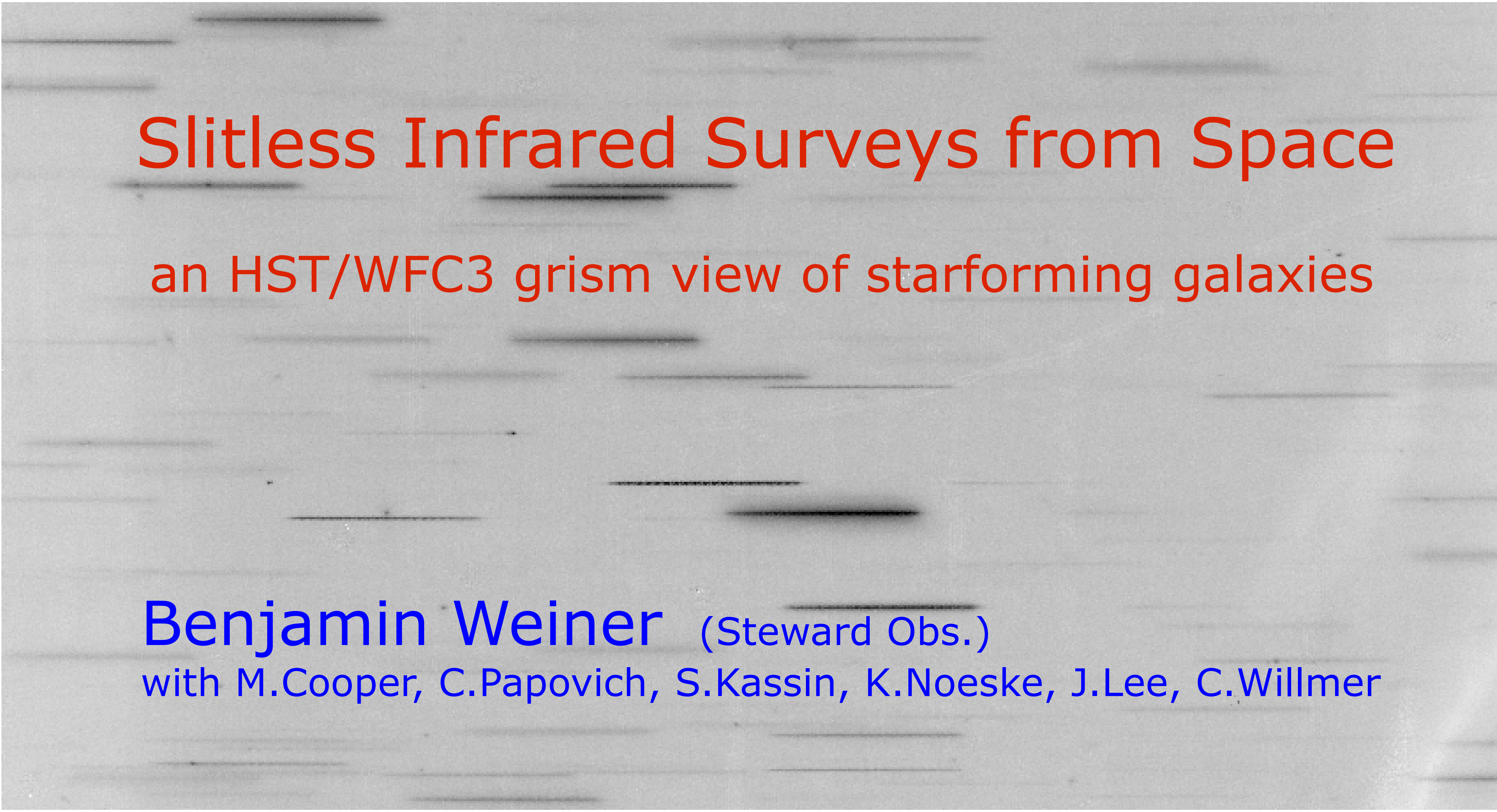


Slitless Infrared Surveys from Space

an HST/WFC3 grism view of starforming galaxies

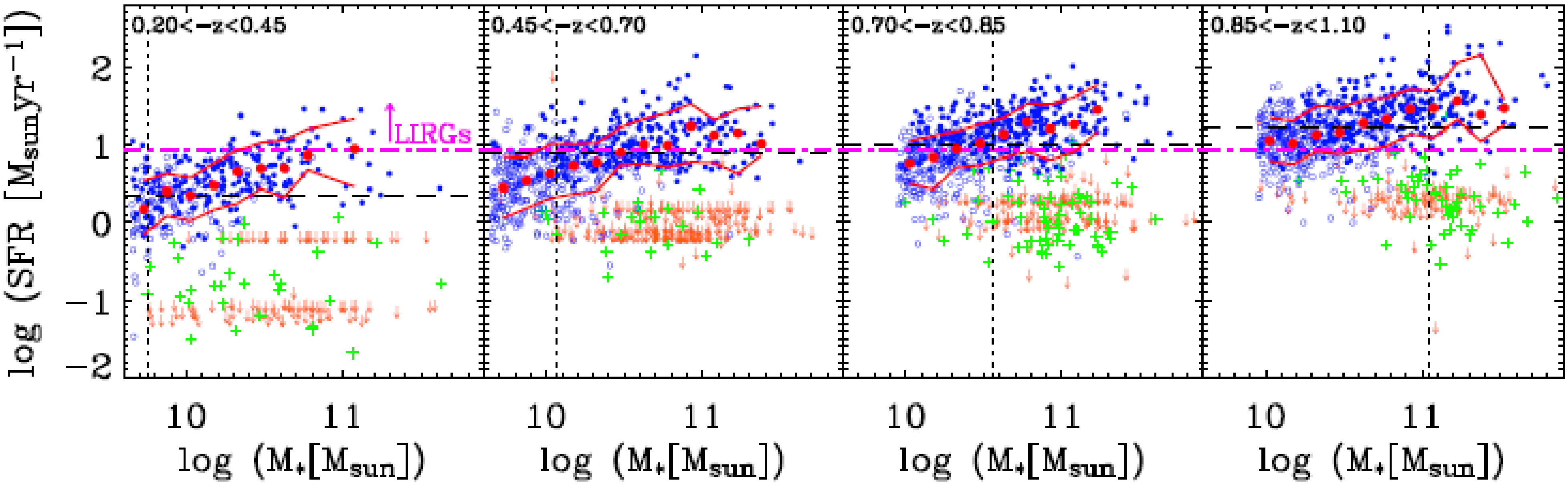
Benjamin Weiner (Steward Obs.)

with M.Cooper, C.Papovich, S.Kassin, K.Noeske, J.Lee, C.Willmer

ARIZONA

With thanks to the WFC3 team
and ST-ECF aXe software group

Context: evolution of star-forming galaxies



Noeske et al 2007

Star forming galaxies are globally more active at z~1.
This is an across-the-board increase in SFR, rather than an increased fraction of brief excursions to high SFR.

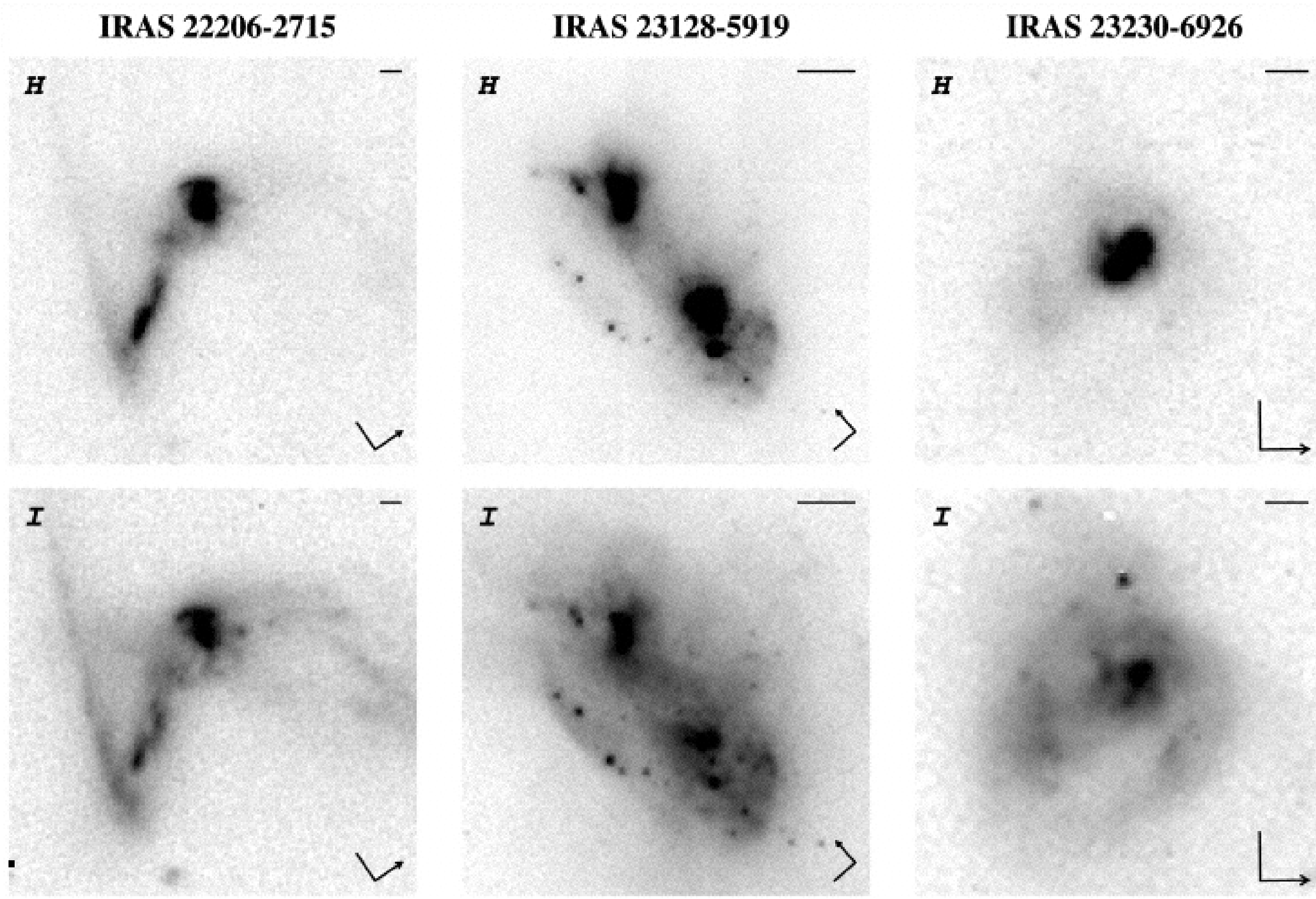
More galaxies are over the Luminous/Ultra-luminous Infrared Galaxy threshold, but this leaves open whether they are similar to local LIRGs/ULIRGs, which are extreme/unusual in the local universe.
Not a higher fraction of mergers; maybe higher gas content.

LIRG: L_IR > 10^11,
SFR > 10 Msun/yr

ULIRG: L_IR > 10^12
SFR > 100

Locally, most LIRGs and nearly all ULIRGs are interacting galaxies, can be classified into merger stages (pair, double nucleus, single nucleus, ...)

Locally, ULIRGs are rare.

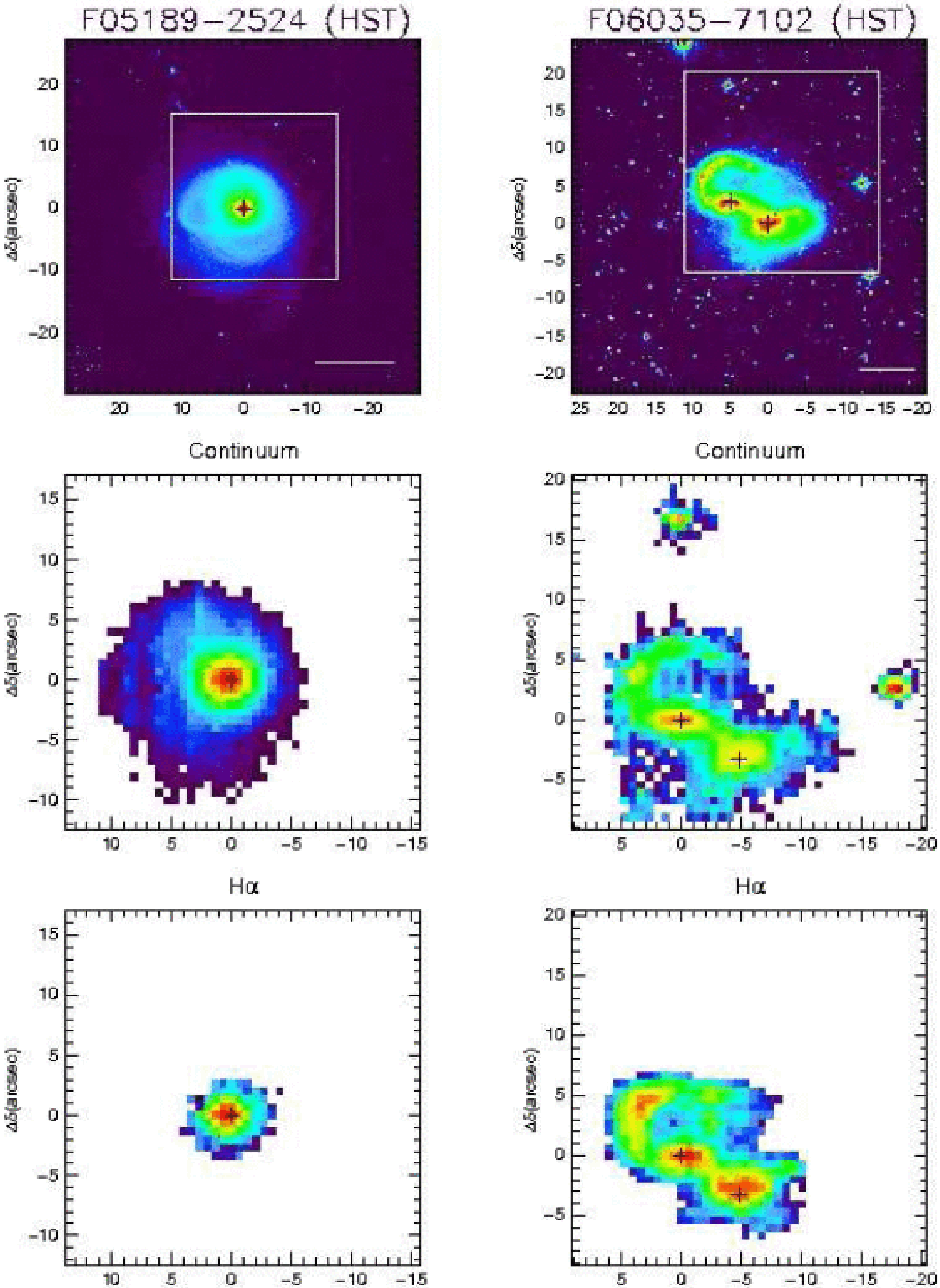


Unclear how LIRG/ULIRG properties extrapolate to high z galaxies.

IRAS-selected ULIRGs at z~0.2
(WFPC2/NICMOS, Bushouse etal 2002)

continuum

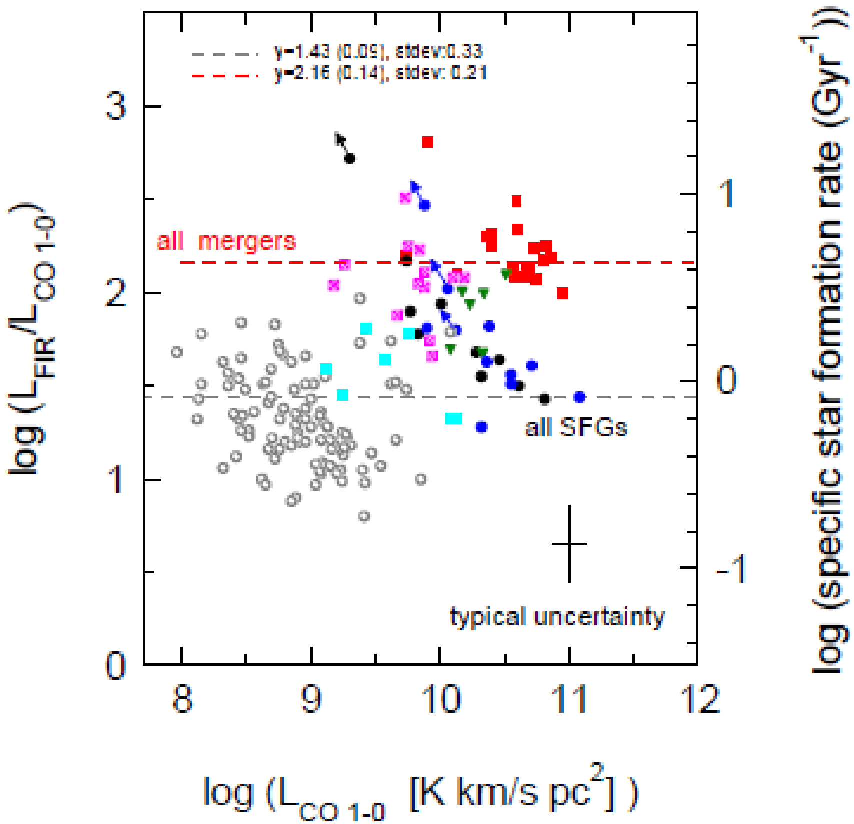
Ha

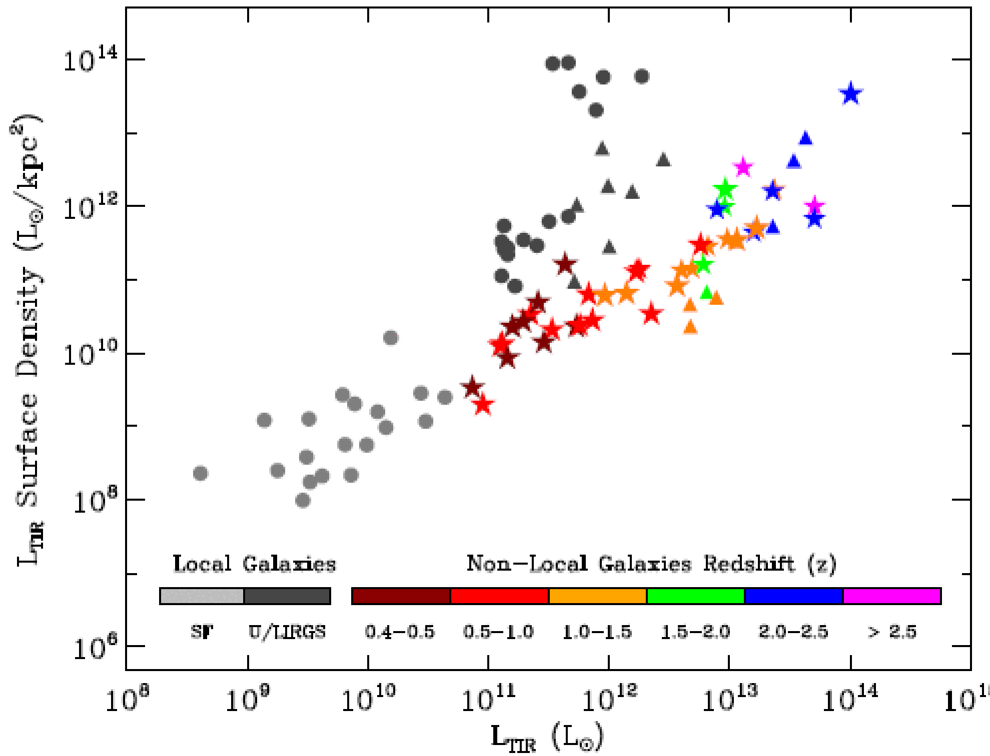


Rodriguez Zaurin et al 2010
VIMOS IFU observations
of low-z ULIRGs

range of morphology and EW;
Ha can be concentrated;
can also show up in outer features;
extinction likely higher in center

Radii are critical to understand physical conditions at high z





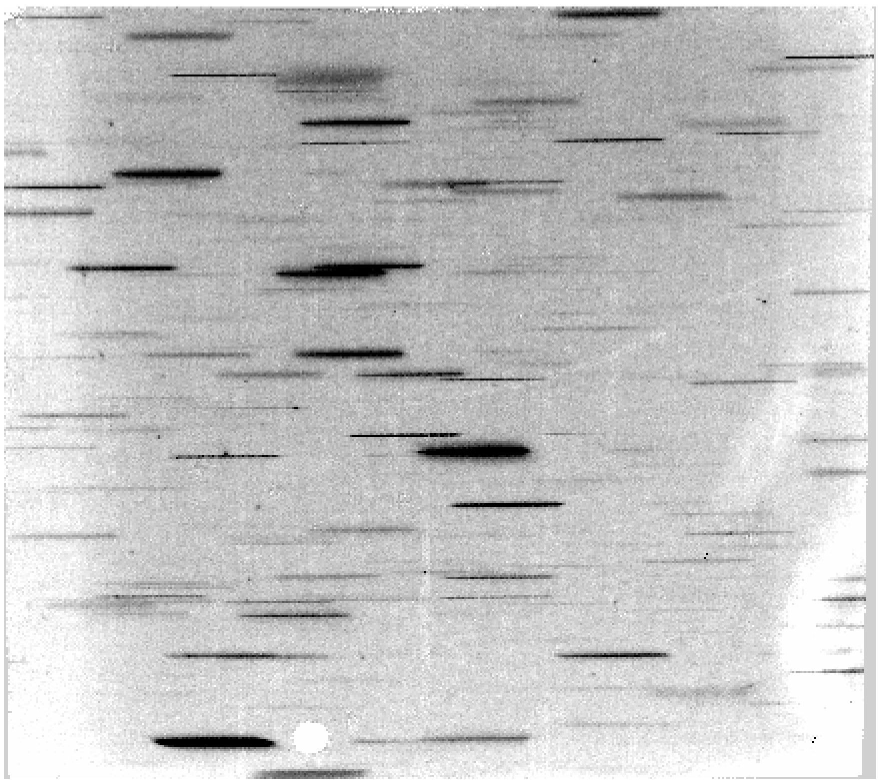
Tacconi et al, Genzel et al 2010:

mergers and ULIRGs are at higher L(FIR)/L(CO), while high-z star forming galaxies are at similar value (SF efficiency) to low-z SFGs. Limited size information suggests high-z SFGs are on Kennicutt-Schmidt relation.

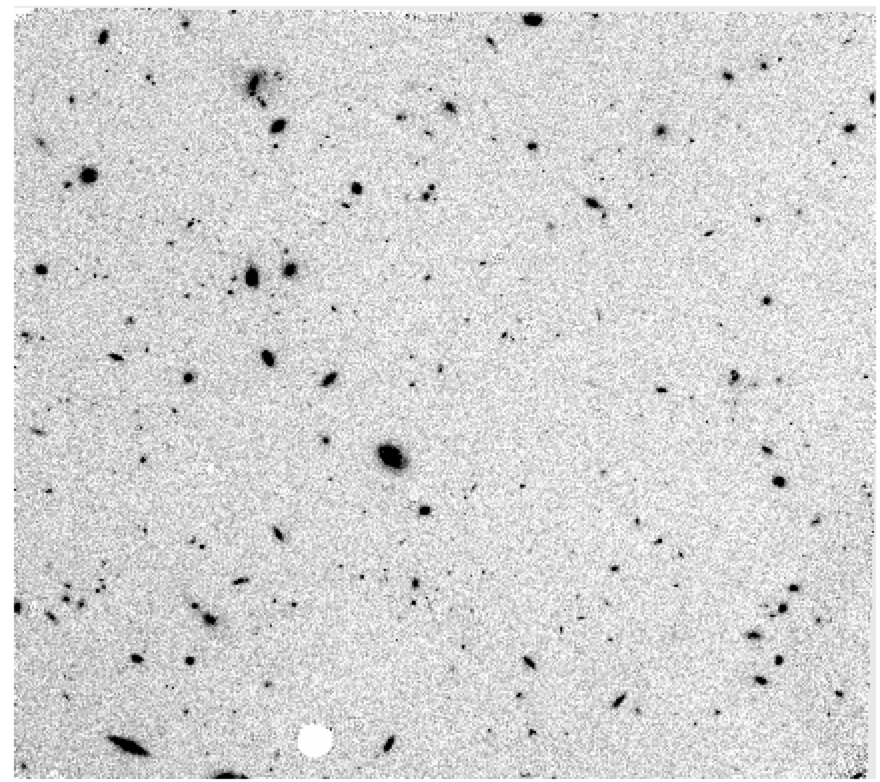
Rujopakarn et al 2010:

high-z very IR-luminous galaxies have larger star-forming radius (in radio or CO) than do local ULIRGs, so there is a difference in L_IR surface density. May explain evolution in IR spectral shapes. But, these sizes are *difficult* to measure.

We would really like to be able to measure H-alpha for a reasonable number of galaxies at z~1. Slitless spectroscopy is possible from space:

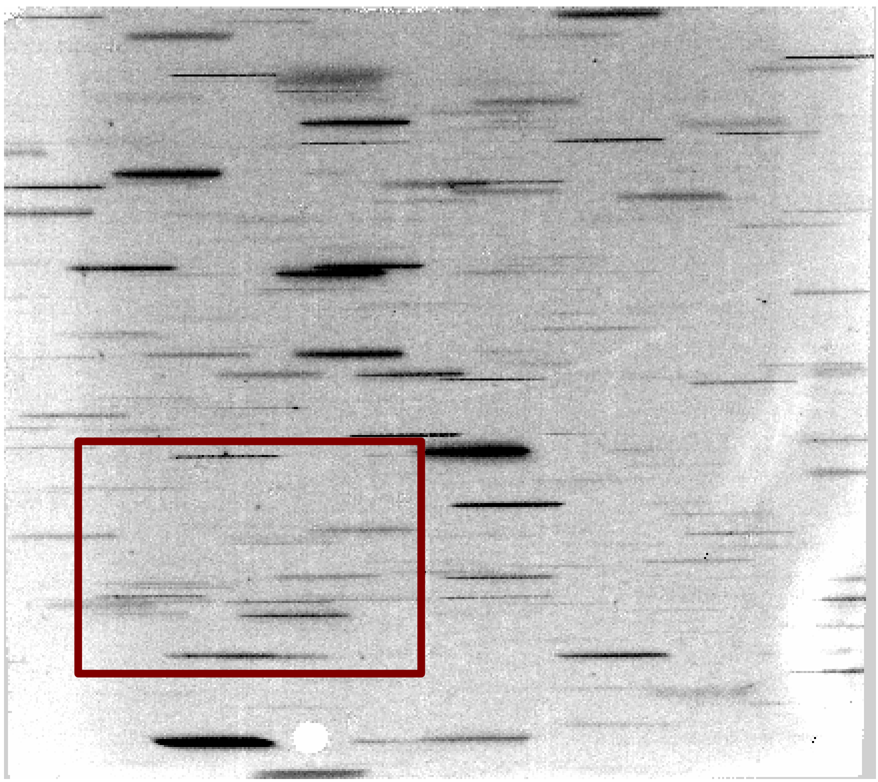


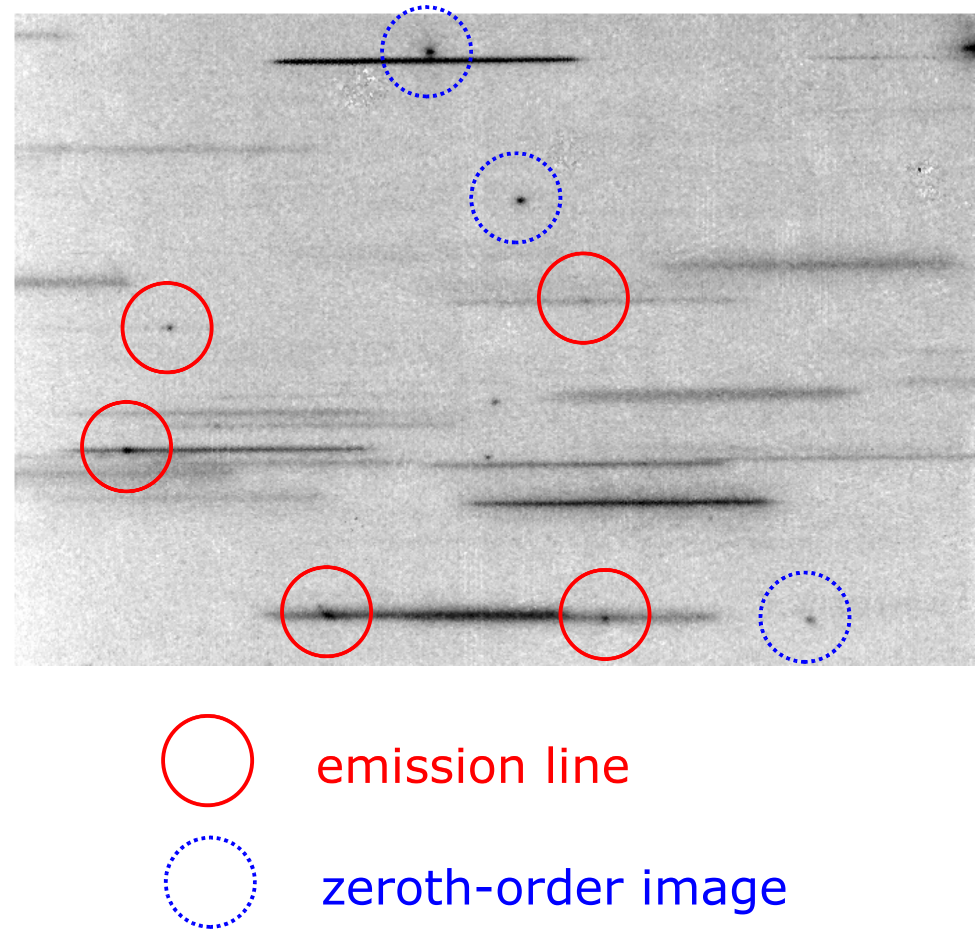
One HST/WFC3-IR slitless grism pointing, 2.1' x 2.1', spectra cover 1.1-1.65 microns at R<300. 5300 sec exposure. Lots of multiplex advantage, at the price of complex data. Low background, high spatial resolution make this possible.



F140W direct image, 800 sec

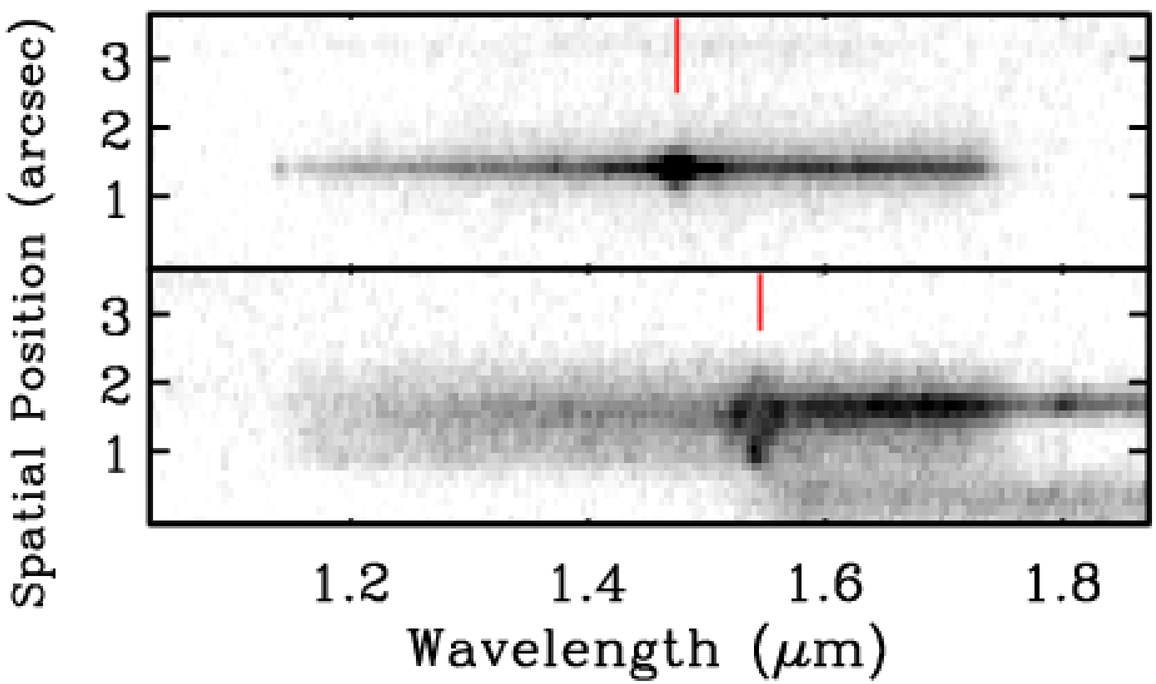
HST's WFC3/G141 measures H-alpha emission at $0.7<z<1.5$, occasional objects with bluer lines at higher z





One grism pointing at 2-orbit depth.
Current programs covering most of GOODS-N (PI Weiner) and the 4 other deep IR imaging Treasury fields (3D-HST, PI van Dokkum)
~260 orbits total

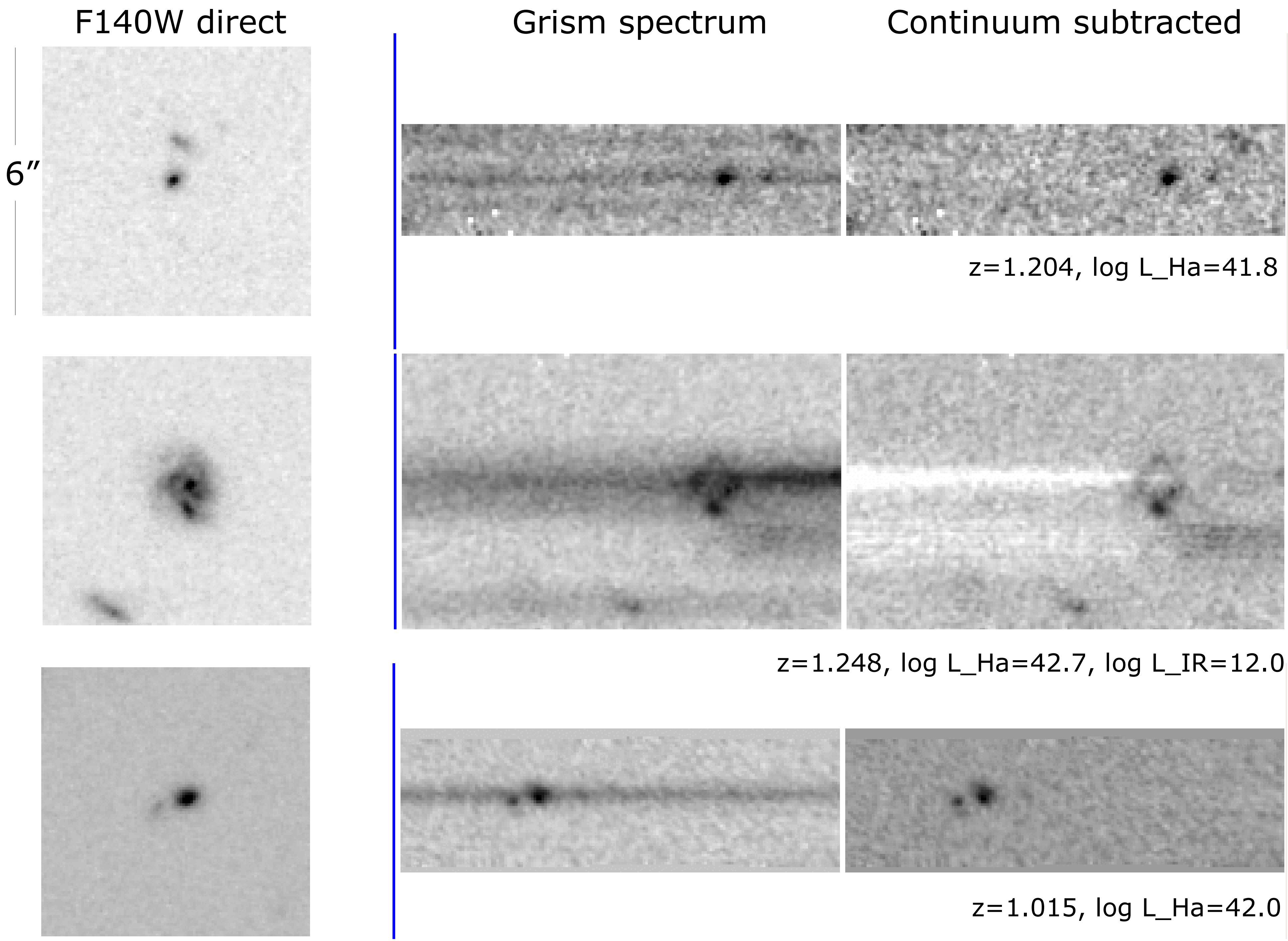
Why is this interesting to IFU spectroscopists?
It's only R<300. But for emission lines,
slitless spectroscopy is *imaging.*



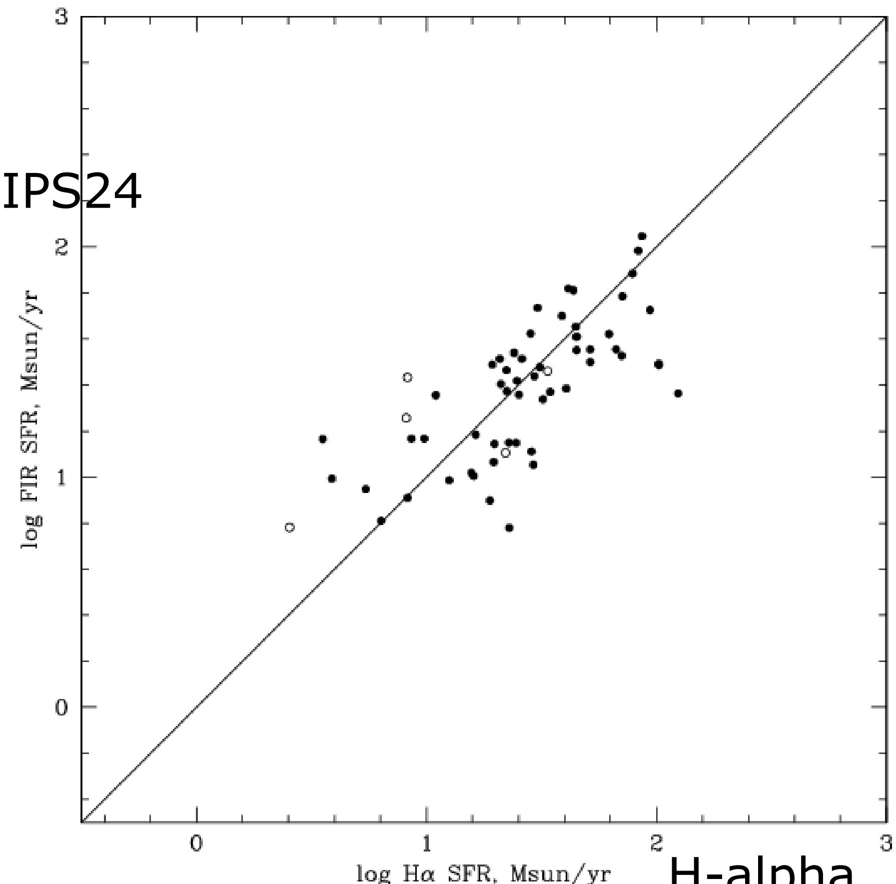
log L_IR=12.4, Ha diameter <3 kpc

log L_IR=12.0, Ha diameter 10 kpc

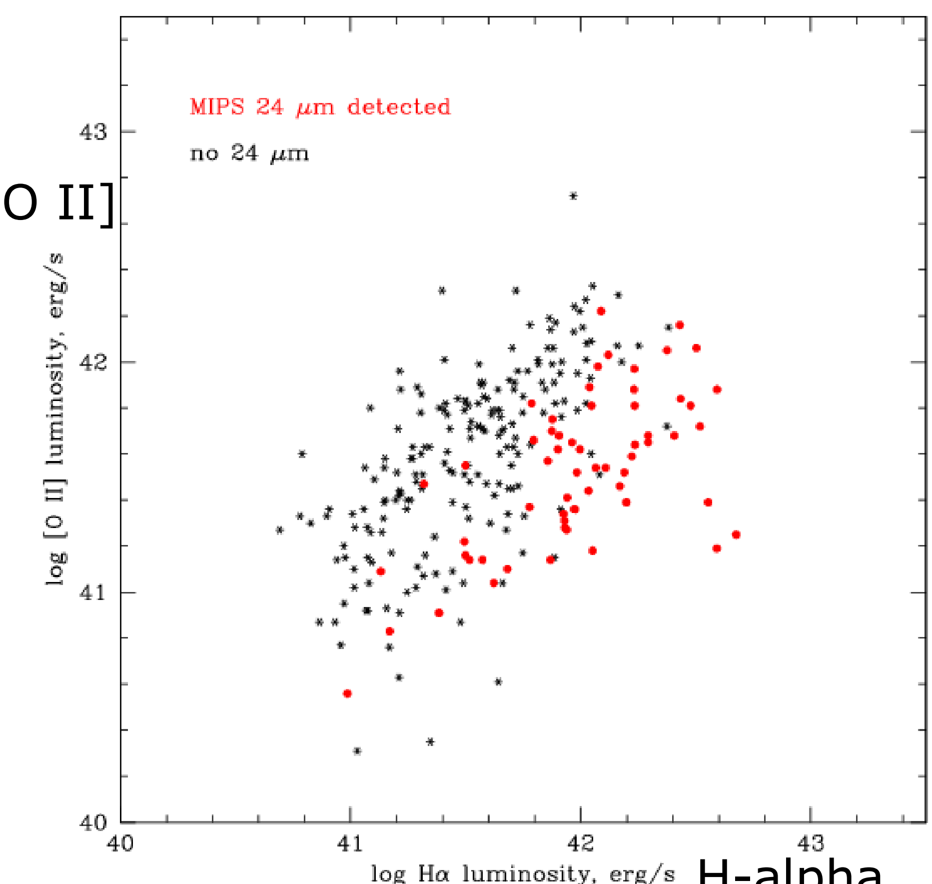
(Spectra reduced by BJW, figure by M. Cooper)


F140W direct
Grism spectrum
Continuum subtracted
6″
z=1.204, log L_Ha=41.8
z=1.248, log L_Ha=42.7, log L_IR=12.0
z=1.015, log L_Ha=42.0

H-alpha is sensitive SFR indicator
independent of metallicity
less affected by extinction than [O II] or UV
but in near-IR, it can be hard to observe and flux-calibrate from ground



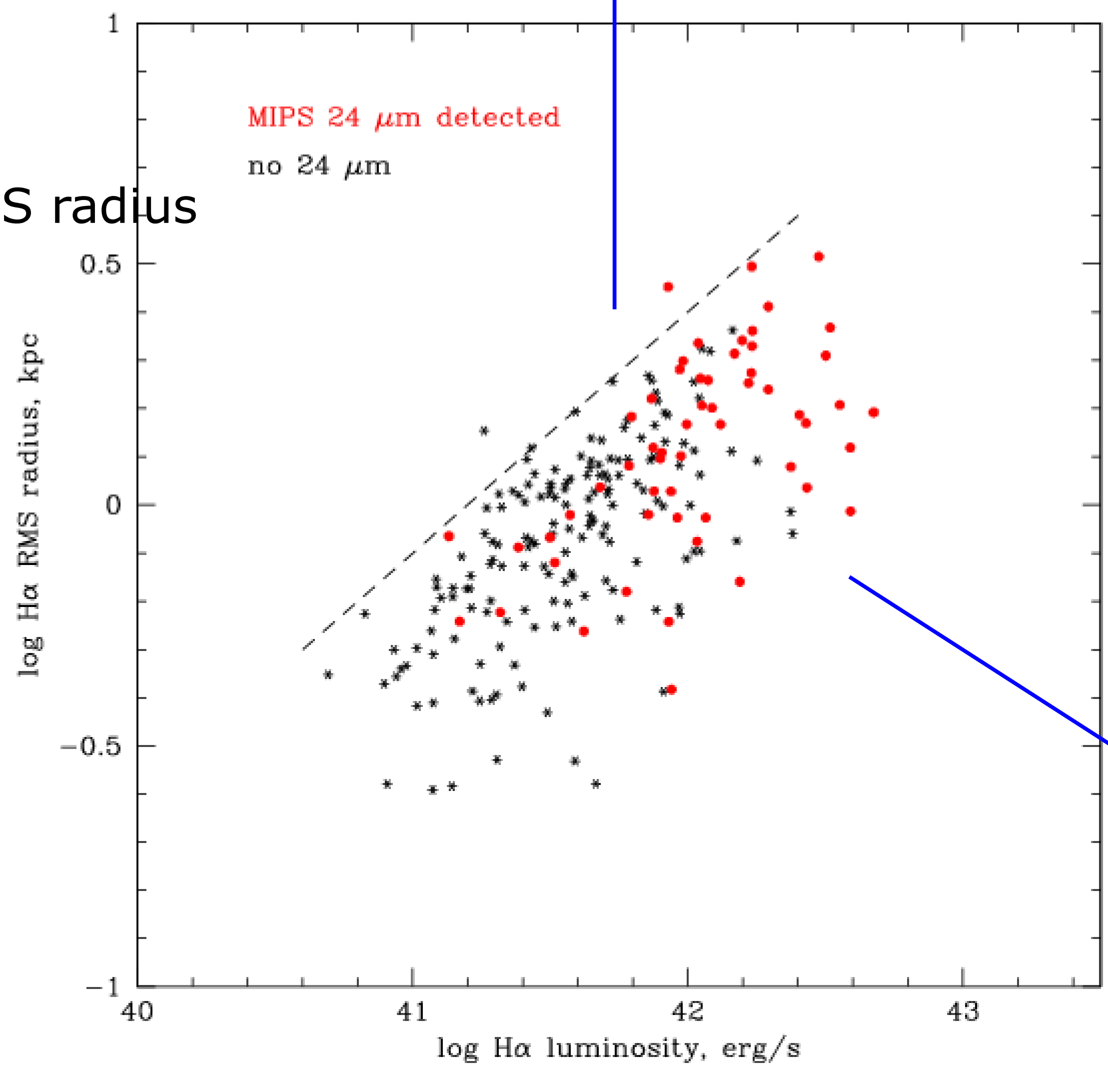
SFRs from grism Ha and MIPS 24 um agree roughly when both are detected. Far-IR limits sensitivity – also only 6” resolution



Significant scatter between Ha and [O II] 3727. MIPS-detected sources and high [O II] are different – likely metallicity effect

SB selection limit

Ha RMS radius



Ha luminosity

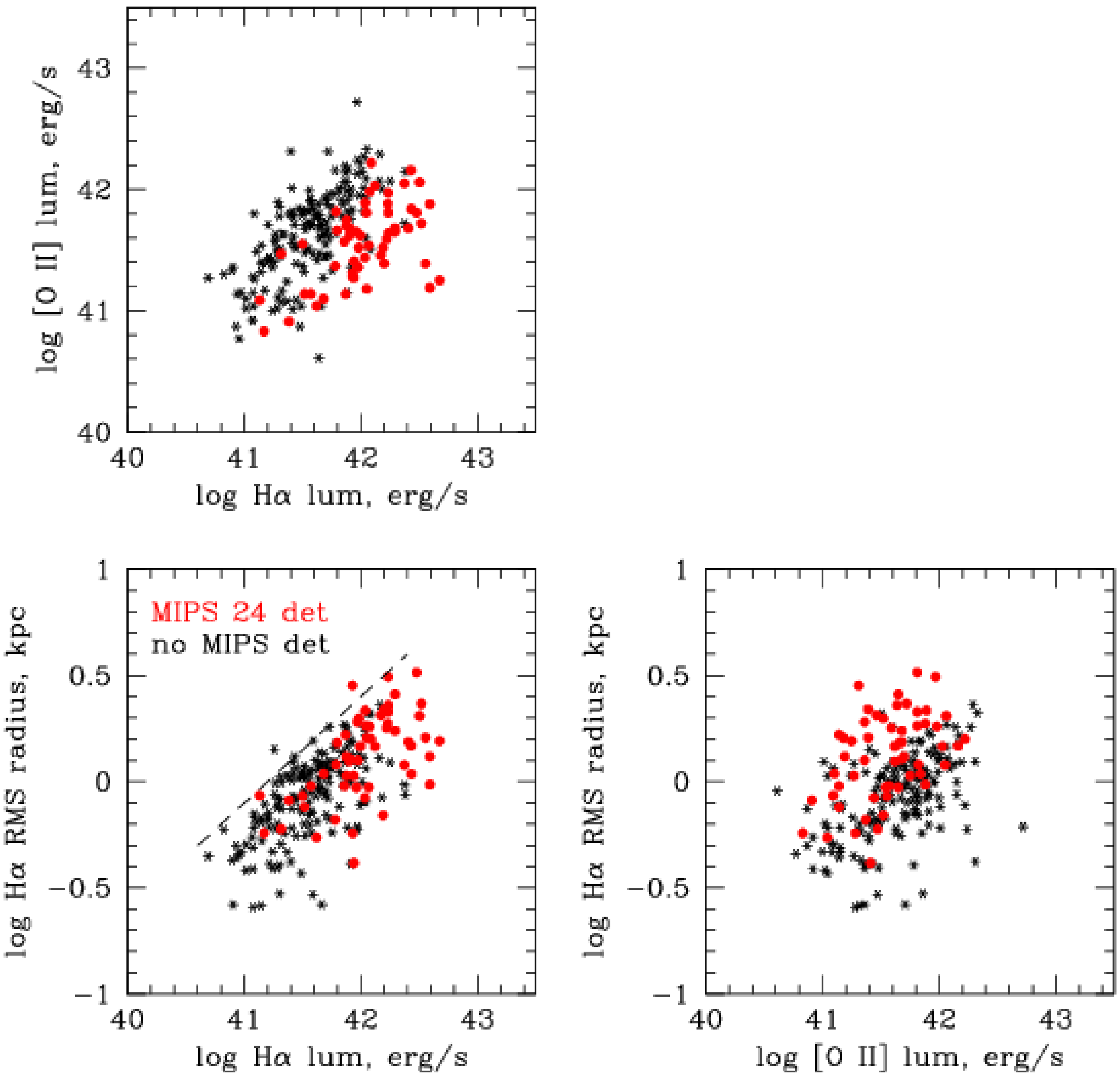
H-alpha sizes measured from slitless emission line images:

subtract continuum, detect emission with SExtractor

Sizes are generally not small, and they are actually biased small by SExtractor deblending of Ha-clumps

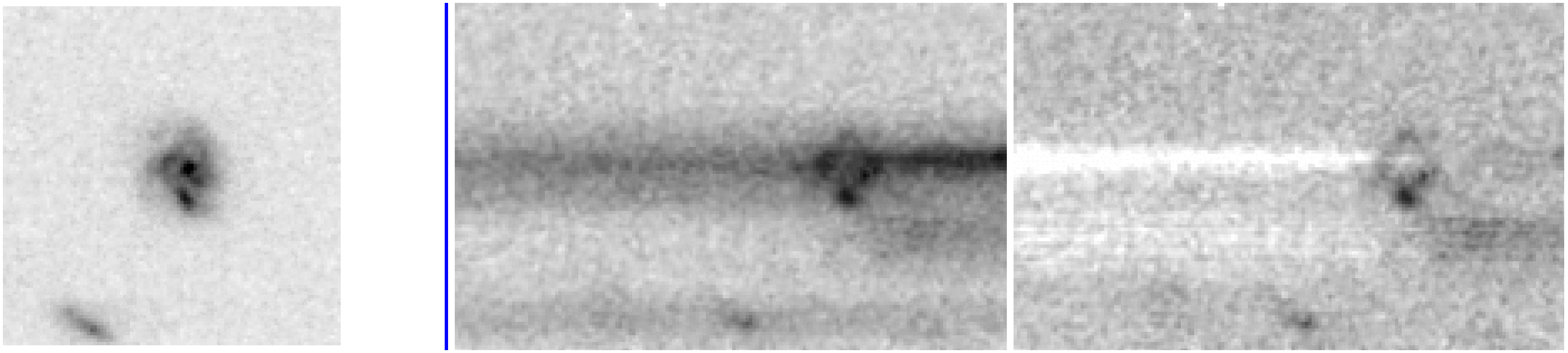
possible lack of Ha-bright small-radius galaxies

[O II] lum



Ha radius

Ha lum



Preliminary results from H-alpha spectroscopy:
high-z star forming galaxies are relatively large in H-alpha.

Despite the low spectral resolution, slitless space
IR spectra yield very rich datasets.
WFC3 speed and area opens the way to survey science.

These point the way to what can be done in the
future with AO or JWST spectrographs.

Coverage of premier deep extragalactic fields
means grism surveys will likely be a resource for
target selection for many projects.

Working at 2-orbit depth, we haven't yet explored what
really deep grism data will yield.