# z~9 Galaxies in the Hubble Frontier Fields

#### Derek McLeod University of Edinburgh

Supervisors: Ross McLure, Jim Dunlop With: Brant Robertson (Arizona), Richard Ellis (Caltech), Tom Targett (Sonoma)

arxiv: 1412.1472

# Why z~9?

Galaxy UV Luminosity Function (LF) well understood at  $z\sim4-8$ , but less so at  $z\sim9$ .

Debate over possible steep drop-off in UV luminosity density - rapid evolution of galaxies?

Implications for cosmic reionization?

#### Previous Studies at z~9

HUDF12 (PI Ellis)

Discovery of six z~9 galaxies

Constraints on faint end of z~9 LF



#### Previous Studies at z~9

HUDF12/XDF (Oesch et al)

Six z~9 galaxies

Steep decline in Iuminosity density?



## Previous Studies at z~9

CLASH (PI Postman)

25 clusters, of more modest depth cf HFF

Three z~9 candidates (Bouwens et al. 2014)



hubblesite.org

## Hubble Frontier Fields

- Six lensing clusters with six blank parallel fields
- Each is of area ~4.5 square arcminutes
- 140 orbits for each cluster and parallel, imaging in seven filters



## Hubble Frontier Fields

Magnification due to gravitational lensing

Inclusion of key  $J_{140}$  filter allowing dual band detections of galaxies longward of the Lyman break

HFF parallel fields - significant extra cosmic volume to search

#### z~9 Galaxies



#### z~9 Galaxies



#### **Depth Maps**







#### Results



#### Shallower drop in luminosity density than previous studies

blue filled circle: Oesch + (2013,2014) blue open circle: Ellis + (2013) blue filled triangle: Ishigaki + (2015) blue open triangle: McLure + (2013)

## Results



Comparison with theoretical models:

Behroozi & Silk (2015) Cai et al. (2014) Khochfar et al. (in prep.) Dayal et al. (2014) Genel et al. (2014) Henriques et al. (2015)

## Results



## Summary

Detection of 12 z~9 candidates in the first two clusters/parallels

Further constraints on the LF at z=9

Drop in SFR density found to be less steep than previous results