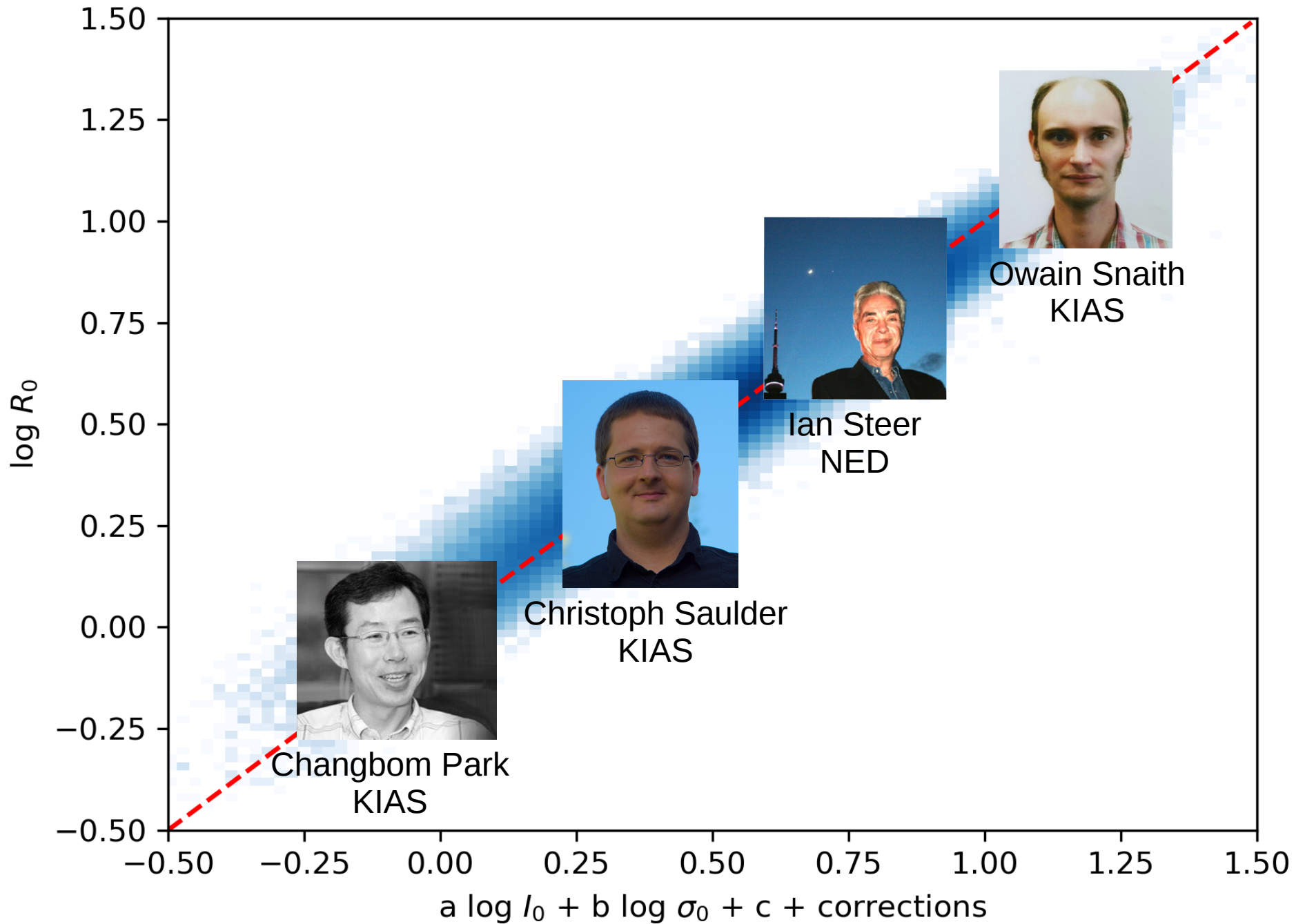


Peculiar motions and the fundamental plane



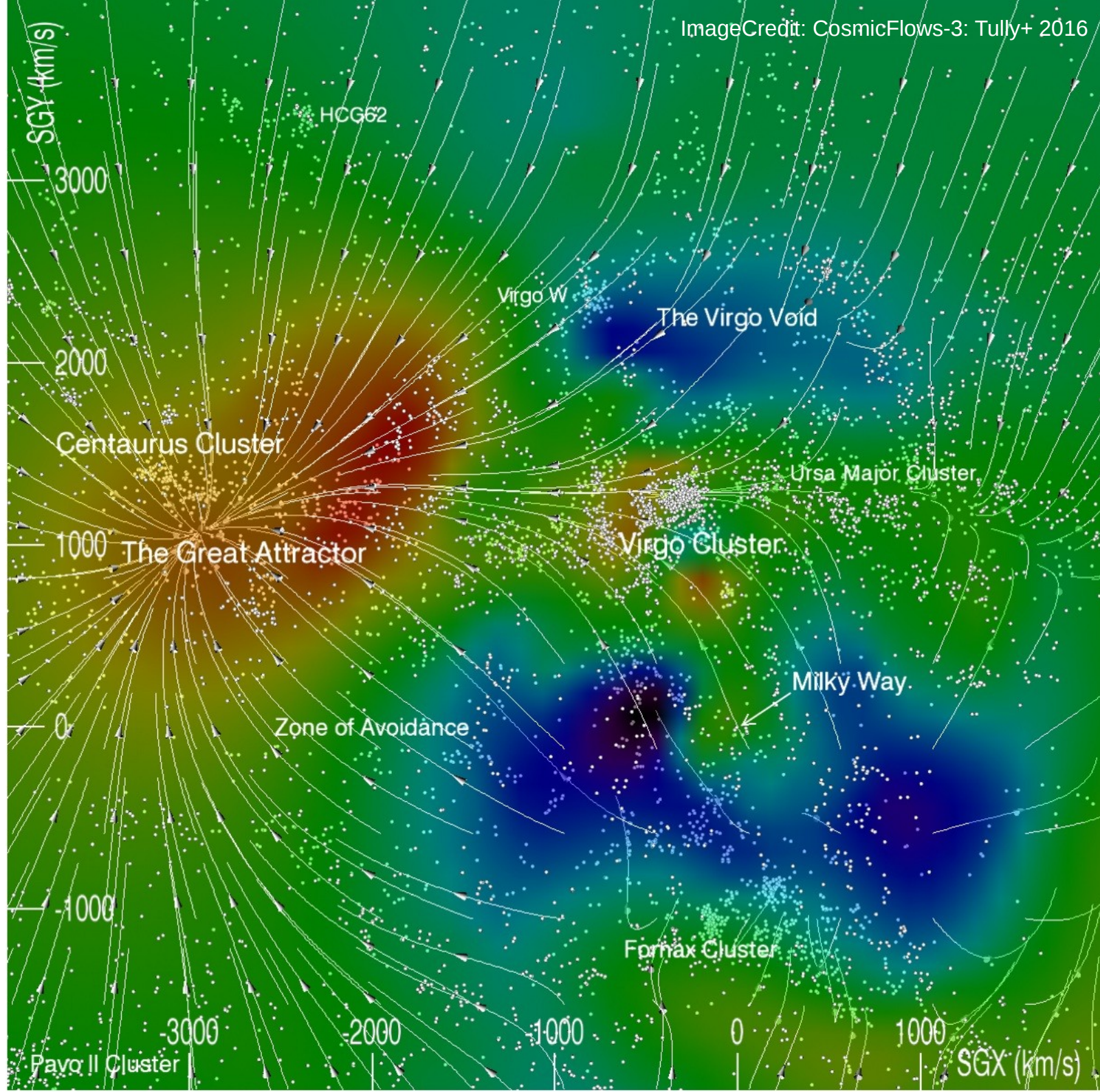
Christoph Saulder (KIAS)

Collaborators



Peculiar motion studies

- At the moment:
- CosmicFlows-3 (Tully+ 2016)
 - Uses primarily Tully-Fisher relation data
 - Collects data from various sources (and methods)
 - All sky
- 6dFGSv (Springob+ 2014)
 - Uses the fundamental plane
 - Only Southern hemisphere (6dFGS follow-up)



The fundamental plane

- Redshift-independent distance indicator for early-type galaxies (ETG)
- Empirical relation between:
 - Surface brightness $\mu_0 = -2.5 \log (I_0)$
 - Central velocity dispersion σ_0
 - Physical radius R_0

$$\log_{10}(R_0) = a \cdot \log_{10}(\sigma_0) + b \cdot \log_{10}(I_0) + c$$

- Accuracy about 20% ... can be improved.

Fundamental plane data

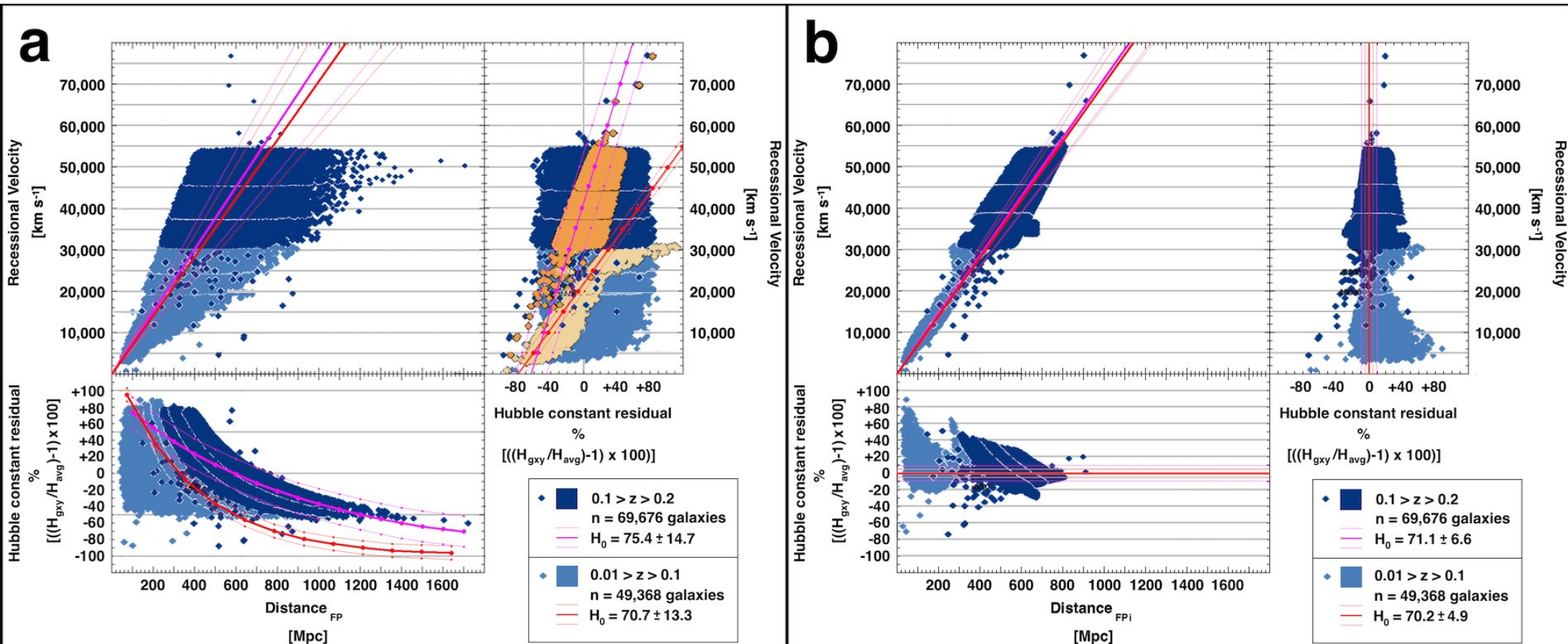
- Data on central velocity dispersion is rare:
 - 6dFGS follow-up (6dFGSv)
 - SDSS/BOSS
 - Taipan galaxy survey (upcoming)
- Notable (large) calibrations:
 - Bernardi+ 2003: ~8000 ETG in SDSS
 - Hyde&Bernardi 2009: ~46500 ETG in SDSS
 - La Barbera+ 2010: ~4500 ETG in SDSS
 - Magoulas+ 2012 & Campbell +2014: ~9000 ETG in 6dFGS
 - Saulder+ 2013: ~93000 ETG in SDSS
 - Saulder+ 2015&2016: ~119000 ETG in SDSS

Further improving the fundamental plane

- Using SDSS and BOSS galaxies selected by colour and light profile → ~280000 ETG ($z < 0.5$)
- Combining it with an extended SDSS group catalogue similar method as in Saulder+ 2016, now in collaboration with Owain Snaith (KIAS).
- Improving the bias and evolution correction
- Environmental dependencies (if any significant)
- New corrections for residuals

First glimpse on our upcoming improvements

- Correcting residuals in redshift bins after removing the standard Malmquist-bias correction (collaboration with Ian Steer (NED))
 - Reduces scatter from $\sim 19\%$ to $\sim 7\%$

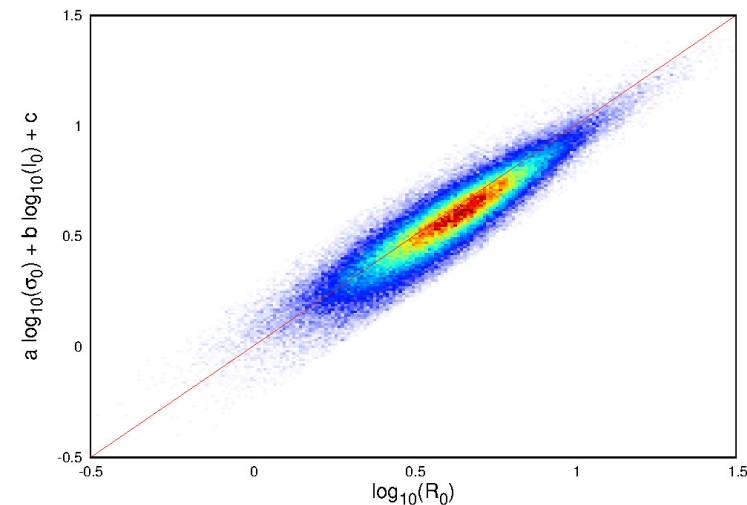
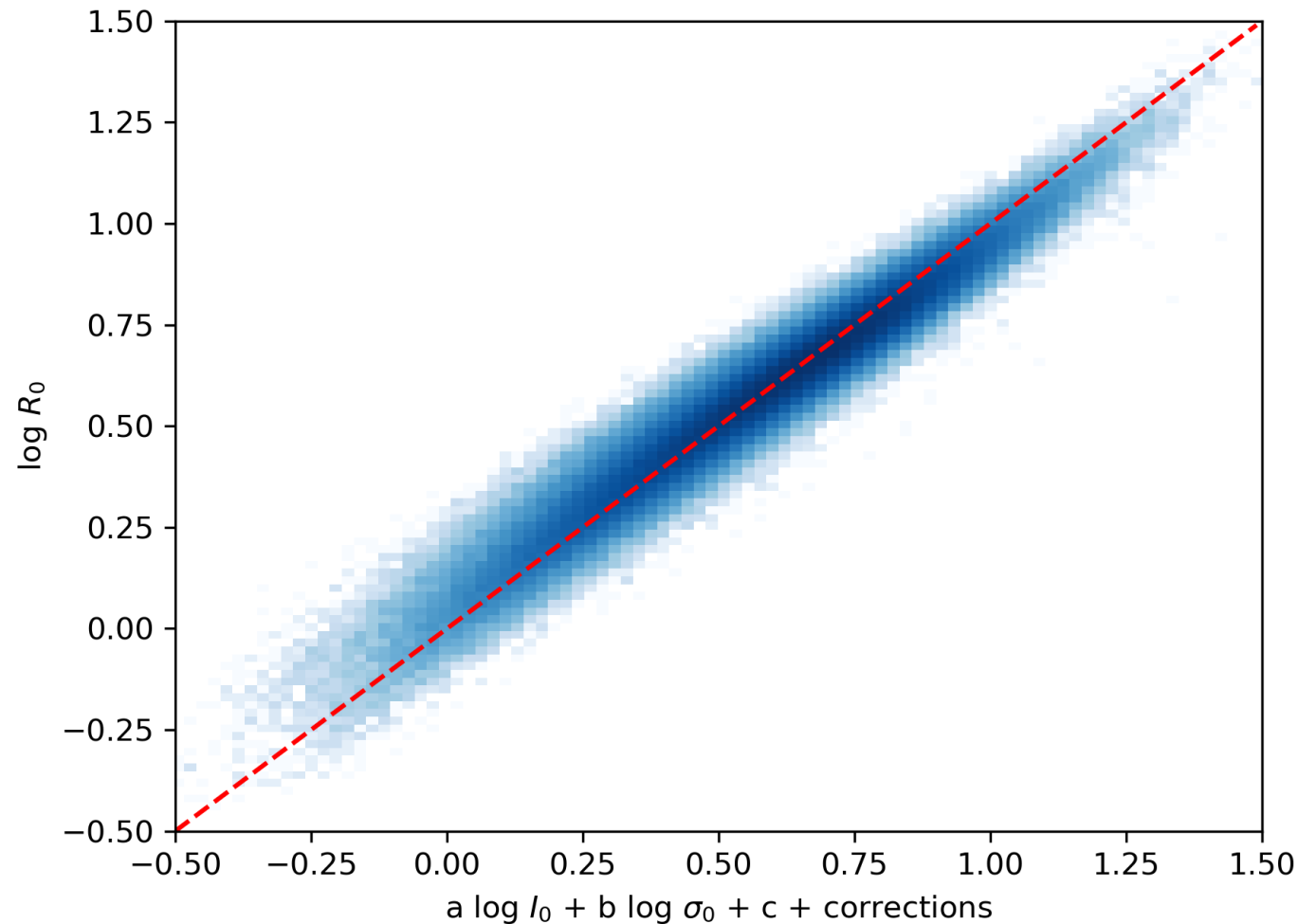


Our new data (work in progress)

- Group catalog: 1 250 000 galaxies up to $z=0.5$
- Fundamental plane for 280 000 galaxies
- Indirect redshift-independent distances for $\sim 800\,000$ galaxies (estimated)
- Largest sample of redshift-independent distances to-this-date
- In the future:
 - using this work to derive additional distances using Supergiant Spiral galaxies and the brightest group galaxies.
 - Including data from 6dFGS and Taipan survey^{9/13}

Current status

- >14% uncertainty for individual galaxies in distance measurements with very crude preliminary data and corrections only partially implemented



Comparison: 18.9% with
119 000 galaxies in
Saulder+2015

Next steps

- Recalibrate group finder algorithm for redshift range of the sample (with Owain Snaith)
- Maybe split BOSS and SDSS sample for fundamental plane calibration
- Analyze additional dependence and minimize residuals (with Ian Steer)
- Derive FP-distances for groups as well
- Test (and improve) the calibrations using other distance indicators, whenever available (based on experience with Saulder+2016 data: a few hundred SN Typ Ia distances for sample galaxies)

Future science applications of the fundamental plane data

- Measuring β (project with Changbom Park)
- Searching for bulk flows
- Mass estimates for superclusters
- Identifying host galaxies of gravitational waves events
- Comparison with other (redshift-independent) distance indicator \rightarrow Hubble parameter

ANY QUESTIONS?

