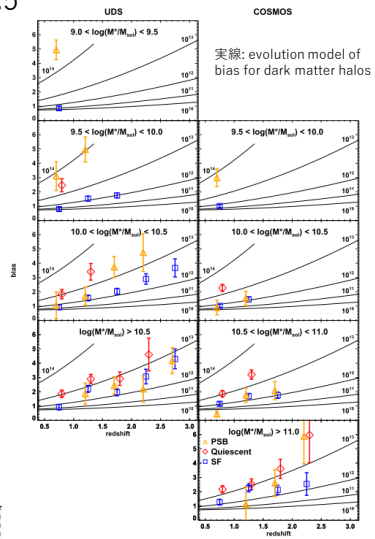
From starburst to quiescence: post-starburst galaxies and their large-scale clustering over cosmic time

Wilkinson et al. 2021, arXiv: 2104.07676

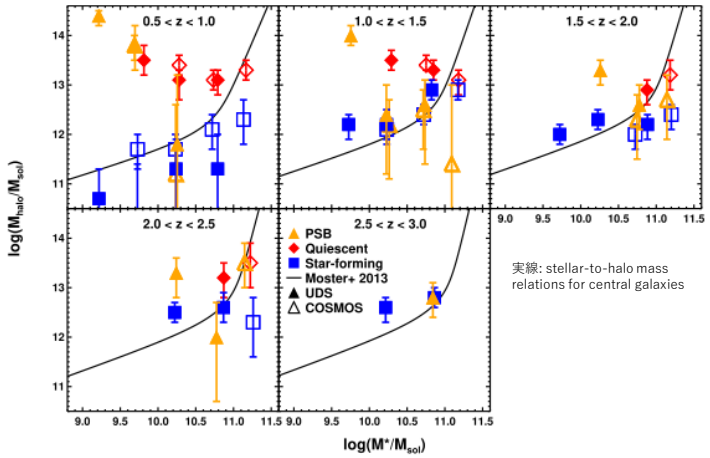
We present the first study of the large-scale clustering of post-starburst (PSB) galaxies in the high redshift Universe ($0.5 < z < 3.0$). We select ~ 4000 PSB galaxies photometrically, the largest high-redshift sample of this kind, from two deep large-scale near-infrared surveys: the UKIDSS Ultra Deep Survey (UDS) DR11 and the Cosmic Evolution Survey (COSMOS). Using angular cross-correlation techniques, we estimate the halo masses for this large sample of PSB galaxies and compare them with quiescent and star-forming galaxies selected in the same fields. We find that low-mass, low-redshift ($0.5 < z < 1.0$) PSB galaxies preferentially reside in very high-mass dark matter halos ($M_{halo} > 10^{14}\,M_{\odot}$), suggesting they are likely to be infalling satellite galaxies in cluster-like environments. High-mass PSB galaxies are more weakly clustered at low redshifts, but they reside in higher mass haloes with increasing look-back time, suggesting strong redshift-dependent halo downsizing. These key results are consistent with previous results suggesting that two main channels are responsible for the rapid quenching of galaxies. While high-redshift ($z > 1$) galaxies appear to be quenched by secular feedback mechanisms, processes associated with dense environments are likely to be the key driver of rapid quenching in the low-redshift Universe ($z < 1$). Finally, we show that the clustering of photometrically selected PSBs are consistent with them being direct descendants of highly dust-enshrouded sub-millimetre galaxies (SMGs), providing tantalising evidence for the oft-speculated evolutionary pathway from starburst to quiescence.

Fig.5



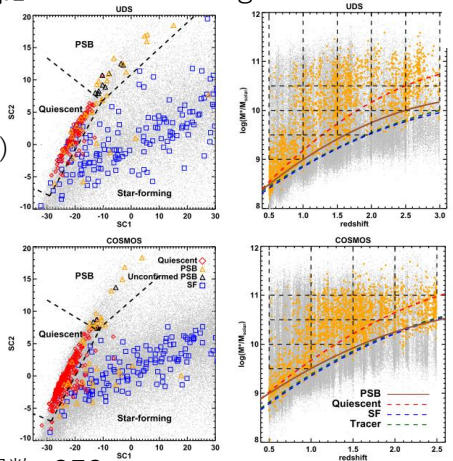
実線: evolution model of bias for dark matter halos

Fig.6



実線: stellar-to-halo mass relations for central galaxies

Fig.1 Fig.2



Star-formationの終わり

- external(environment)
- internal(secular)

→ 遷移期の銀河(Post-StarBurst: PSB)
(Balmer吸収+UV, nebula lineがない)

PSB phaseに突入するメカニズム

- Stellar feedback
  induced by major merger (z~1)
- AGN feedback at the end of
  merger-induced starburst (low-z)
- Environment (z<1)

赤方偏移によるPSBの性質の違い

- z>1 : compact, high Sersic index,
  星質量関数 ~ quiescent
- 0.5<z<1 : low Sersic index, 星質量関数~SFG

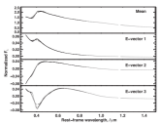
→ Clustering解析によって、PSBのいる環境のM*, z依存性
→ quenchingに関わるメカニズムを考察する

Sample (~4000 PSB)

- UKIDSS UDSとCOSMOSの多波長データをSEDフィッティング
- Wild+2014のPCA techniqueによってSF(dusty含む), Quiescent, PSBを分類: 3種のeigen spectraのamplitude(SC)による分類(Fig.1)
- 90% mass completeness limitはFig.2の通り

Analysis

Cross correlation → 銀河のCCFをhaloのCF x biasでフィット
→ bias(high mass haloへの偏在度合), halo mass



PSBの環境の星質量、赤方偏移による変化

- low-mass & low-redshift (0.5<z<1)のPSBはhigh-mass halo (>$10^{14}M_{\odot}$)
  → dense environmentでquenchしたlow-mass satellites
- high-mass PSBはlow-zなほどlow-mass halo (weakly clustered) → halo downsizing

→ Secular quenchingはhigh-z(z>1.5)で支配的(gas-rich merger)
& low-z(z<1)では特にlow-mass銀河でenvironmental quenchingが効く

PSBとSMGの関わり

SMGのbiasを1Gyrだけ進化させると、high-mass PSBのものとよく一致する

Fig.7

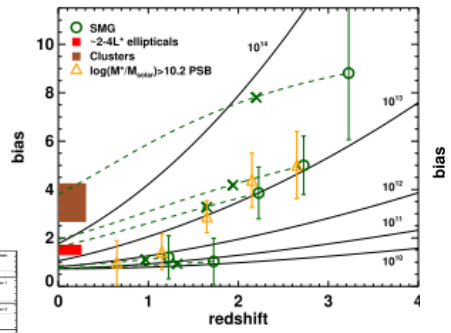


Fig.2 of Wild+2014

M*, SFRとbias(halo mass)の関係(low-z)

Clusteringの強さ(bias)とSFRには相関があり、その関係は連続的である
→ halo massが星形成活動を調整するシナリオと一致

Fig.9