

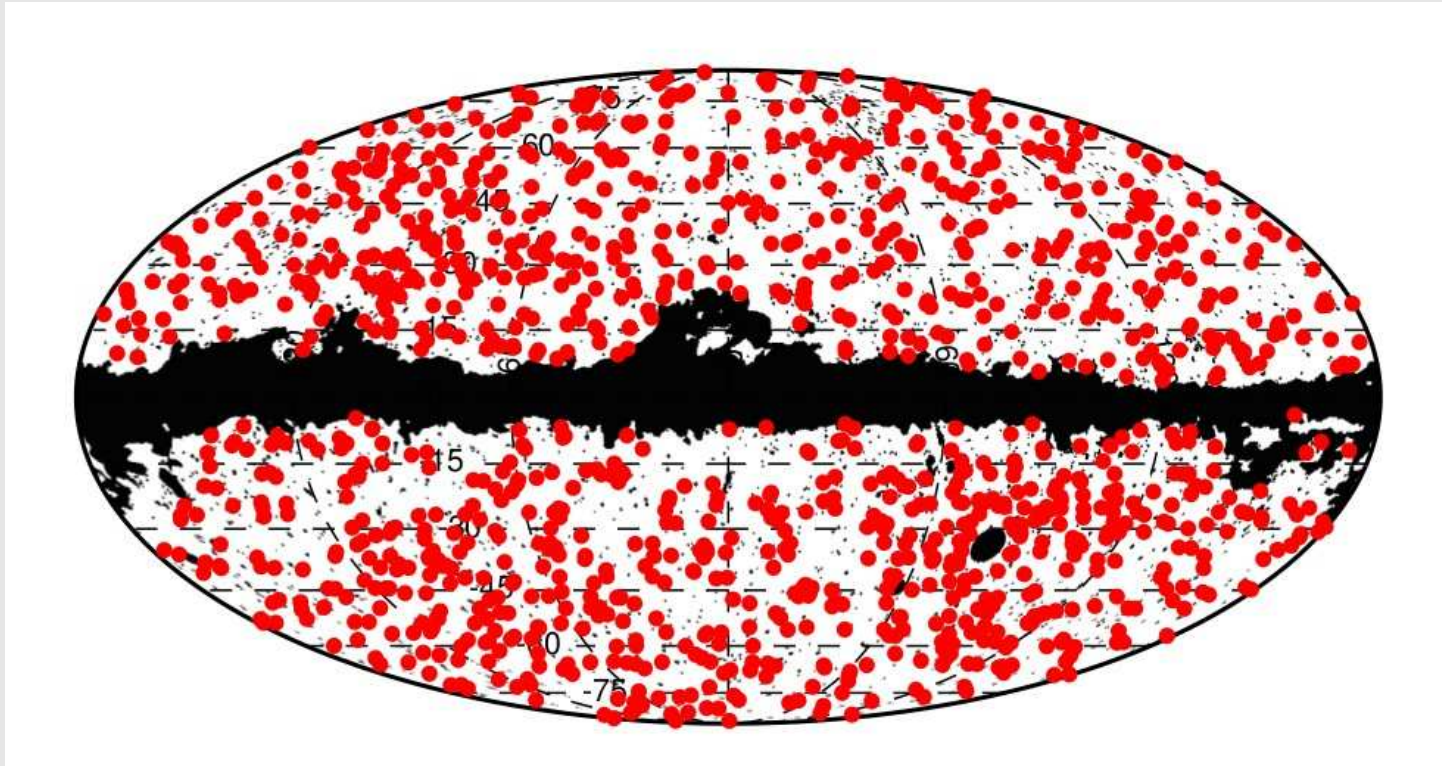
# Optical observations of Planck galaxy clusters with RTT150 telescope

Planck collaboration,

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*1 — IKI, 2 — Kazan Federal University, 3 — TUG, 4 — IAS, 5 — MPA,*

## PSZ1 catalogue



Total — 1227, confirmed — 861, known — 683,  
new — 178, candidates — 366

- new clusters should be confirmed and their redshifts should be measured
- extensive optical follow-up programme, see *Planck collaboration, 2013, arXiv:1303.5089*

# Russian-Turkish 1.5-m Telescope (RTT150)



- Produced at LOMO, St.-Petersburg, Russia
- Installed at Bakyrlytepe, Turkey, first light in 2000
- Operated by KFU, IKI and TUG
- More than 100 dark and grey nights (KFU and IKI time) allocated for Planck SZ sources during last 3 years

# Russian-Turkish 1.5-m Telescope (RTT150)



*TFOSC* — TUBITAK Faint Object Spectrograph and Camera  
similar to, e.g., ALFOSC at *NOT* and others



## 6-m telescope of SAO RAN (BTA)



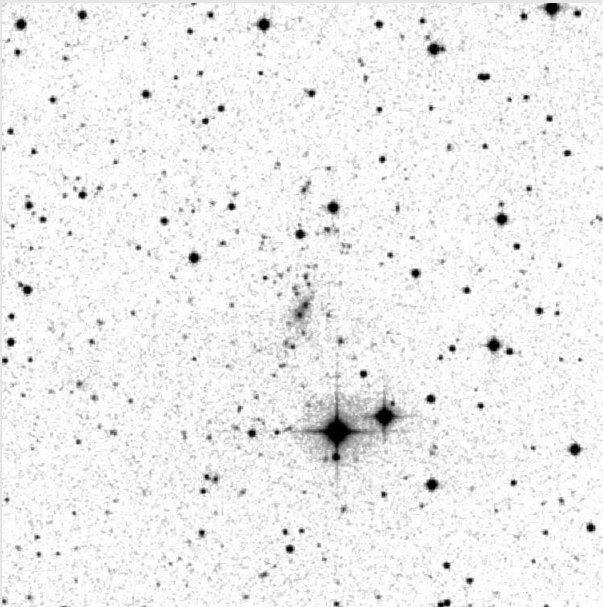
*SCORPIO* spectrograph and camera

Afanasiev & Moiseev, 2005  
arXiv:astro-ph/0502095

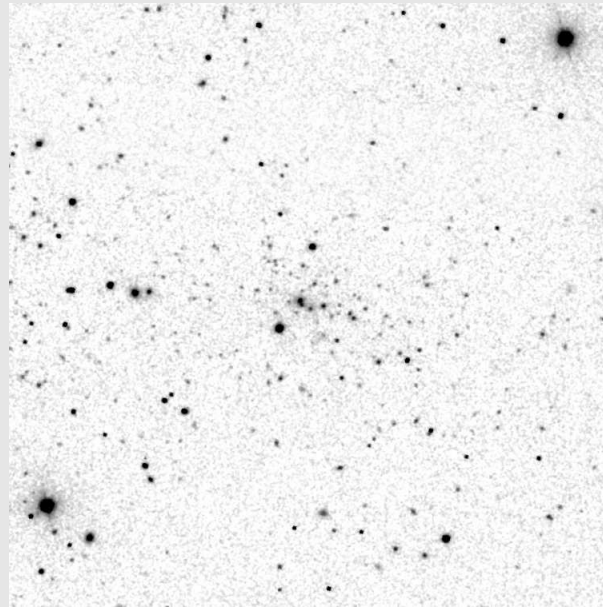
# Optical identifications of galaxy clusters

The procedure is based on *400d* X-ray galaxy cluster survey

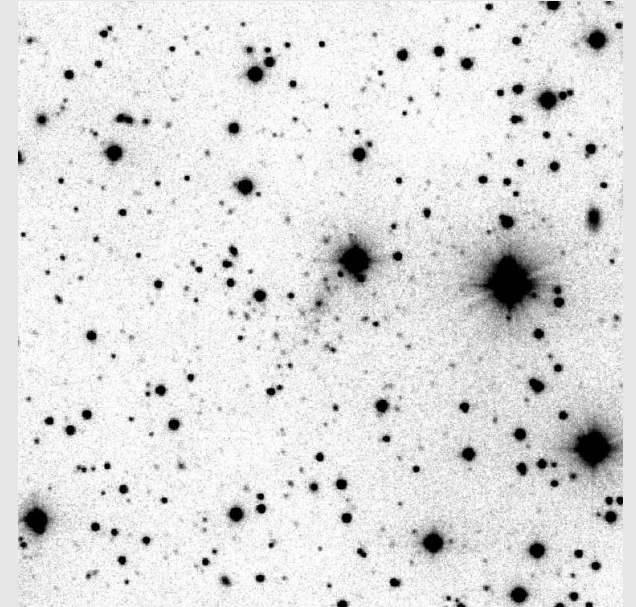
(Burenin et al., 2007, the data were used in Vikhlinin et al., 2009)



*DSS*,  $z = 0.227$



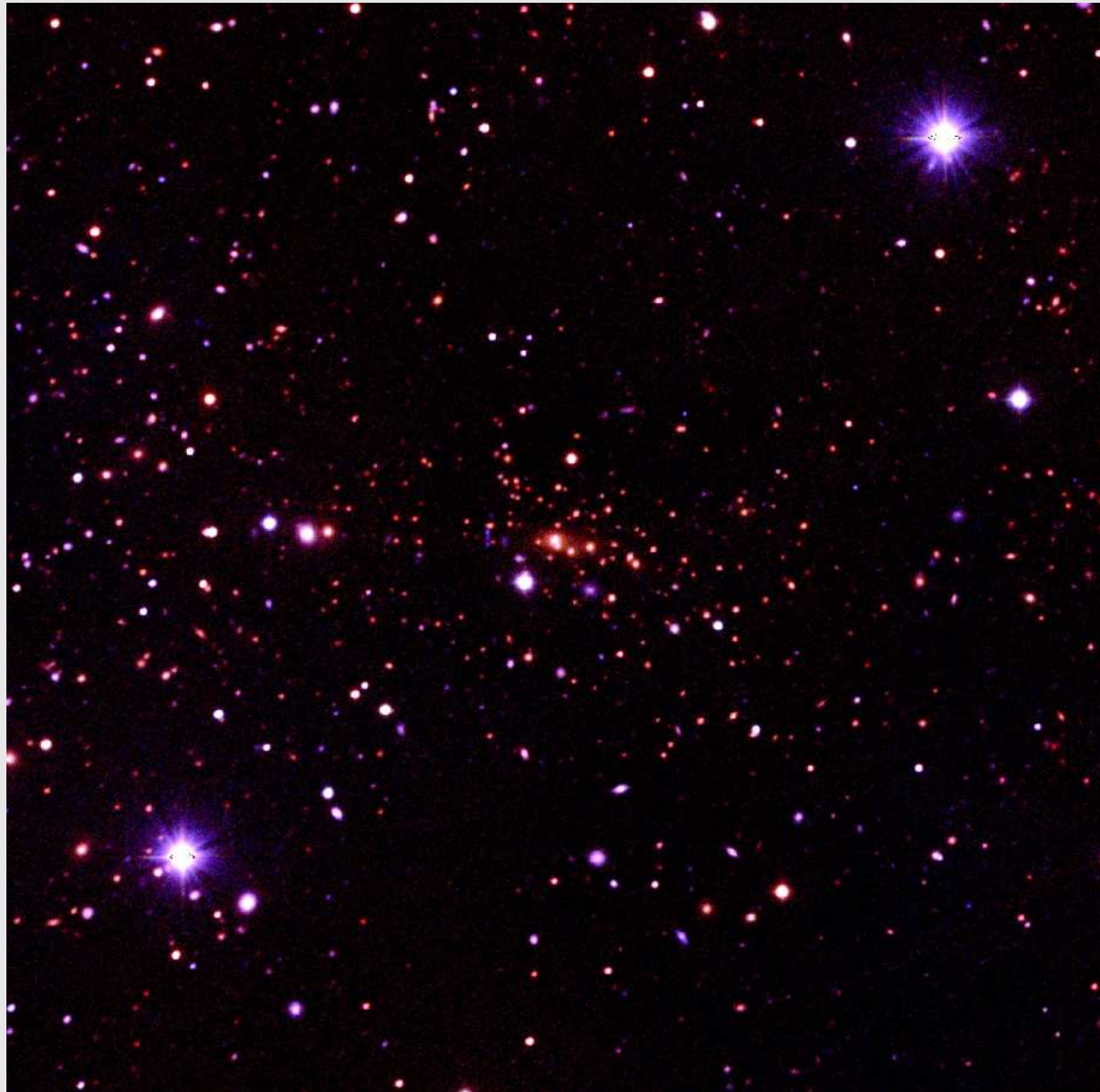
*SDSS*,  $i'$ ,  $z = 0.436$



RTT-150,  $i$ ,  $z = 0.83$

The field size — 1 Mpc

## Direct images



PSZ1 G098.24-41.15,  $z = 0.4362$



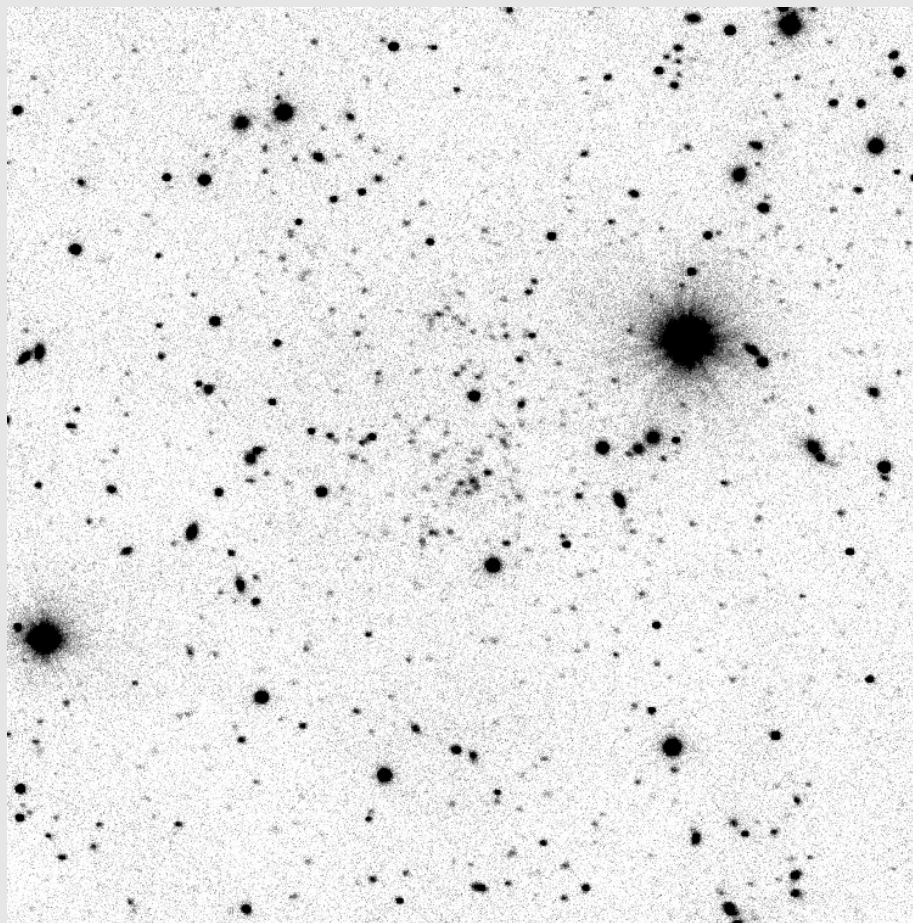
## Direct images



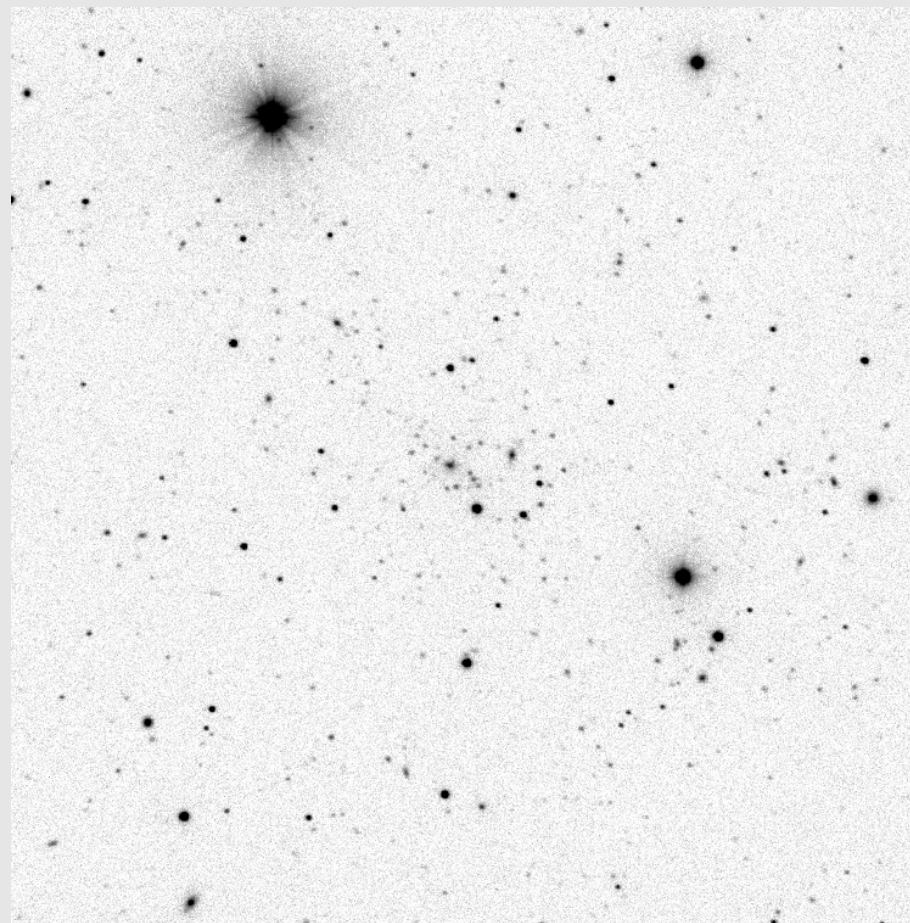
PSZ1 G100.18-29.68,  $z = 0.485$



## Identification examples

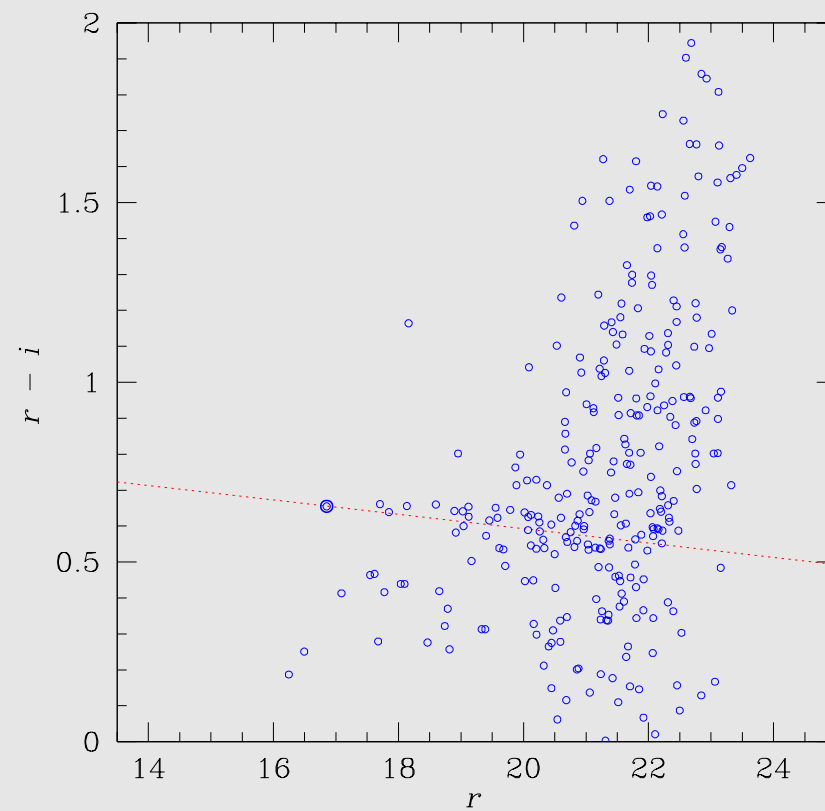
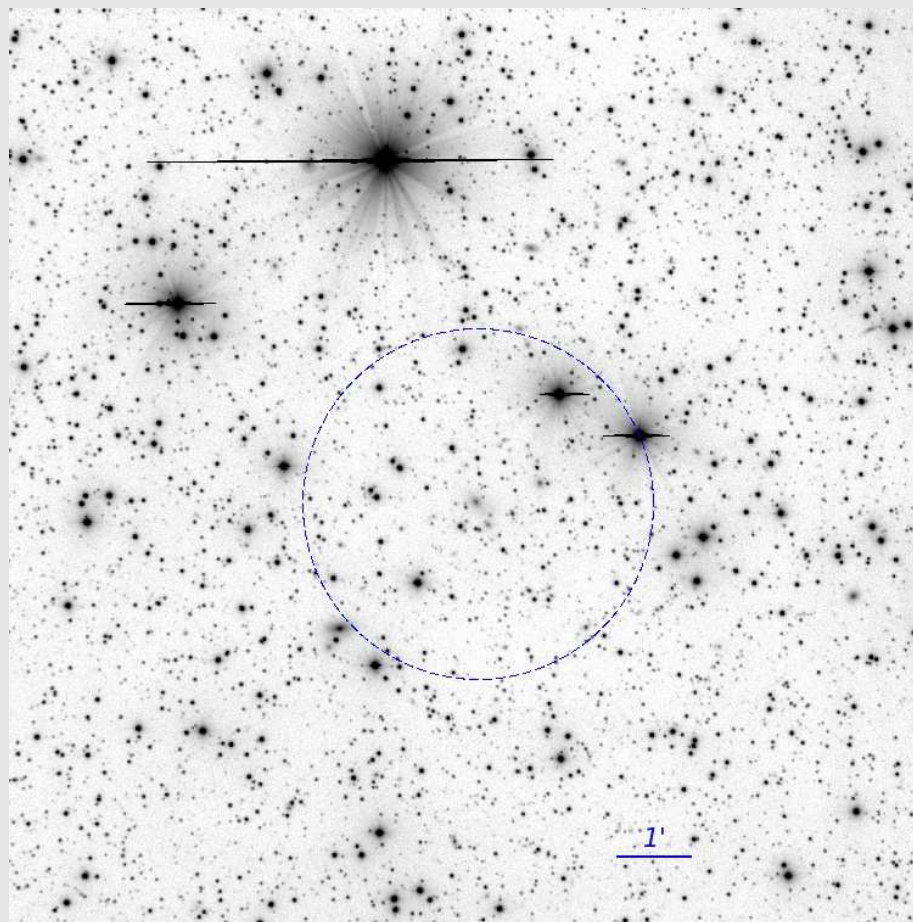


PSZ1 G084.04+58.75,  $z = 0.731$   
too distant, not detected in SDSS



PSZ1 G048.22-65.03,  $z \approx 0.42$   
no SDSS data

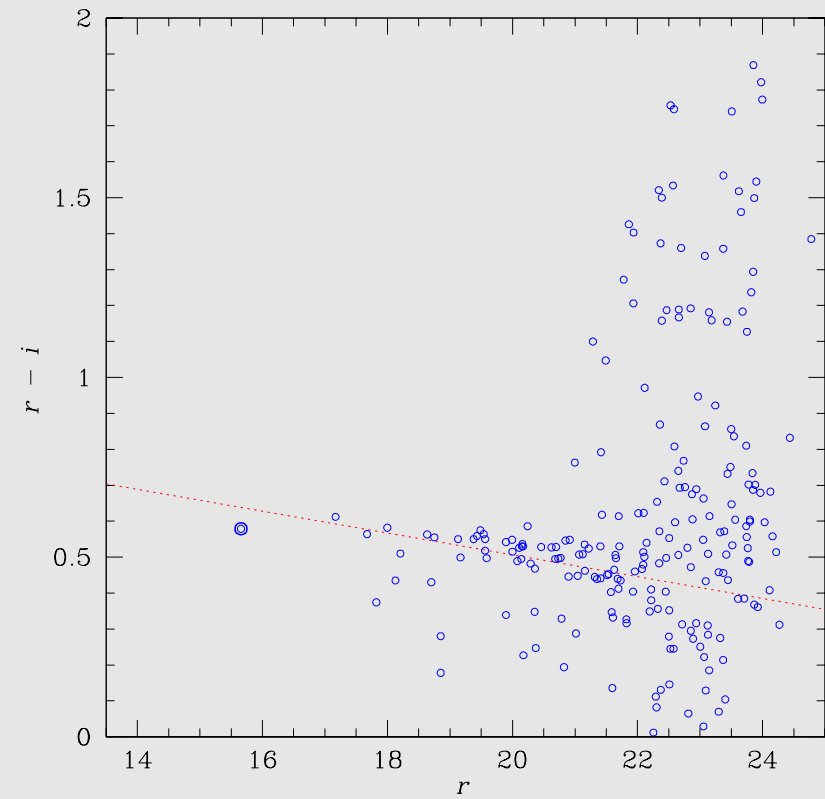
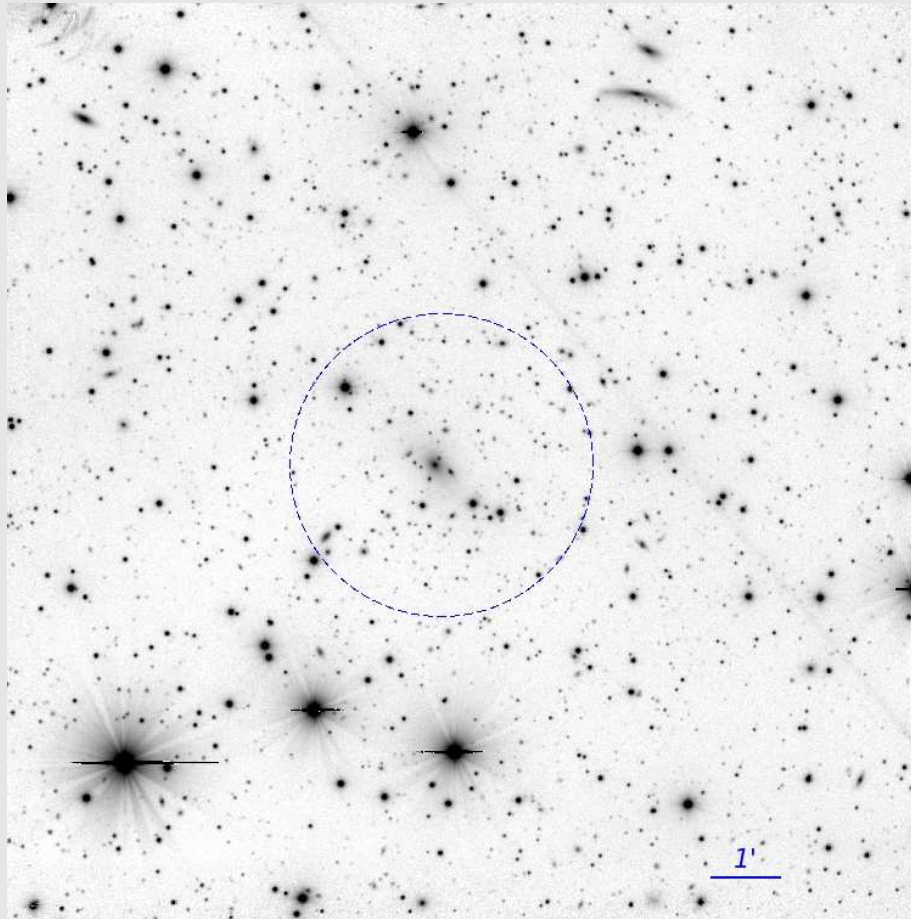
## Clusters at low $b$



PSZ1 G060.12+11.42,  $z \approx 0.30$   
low  $b$  (not detected in DSS), no SDSS



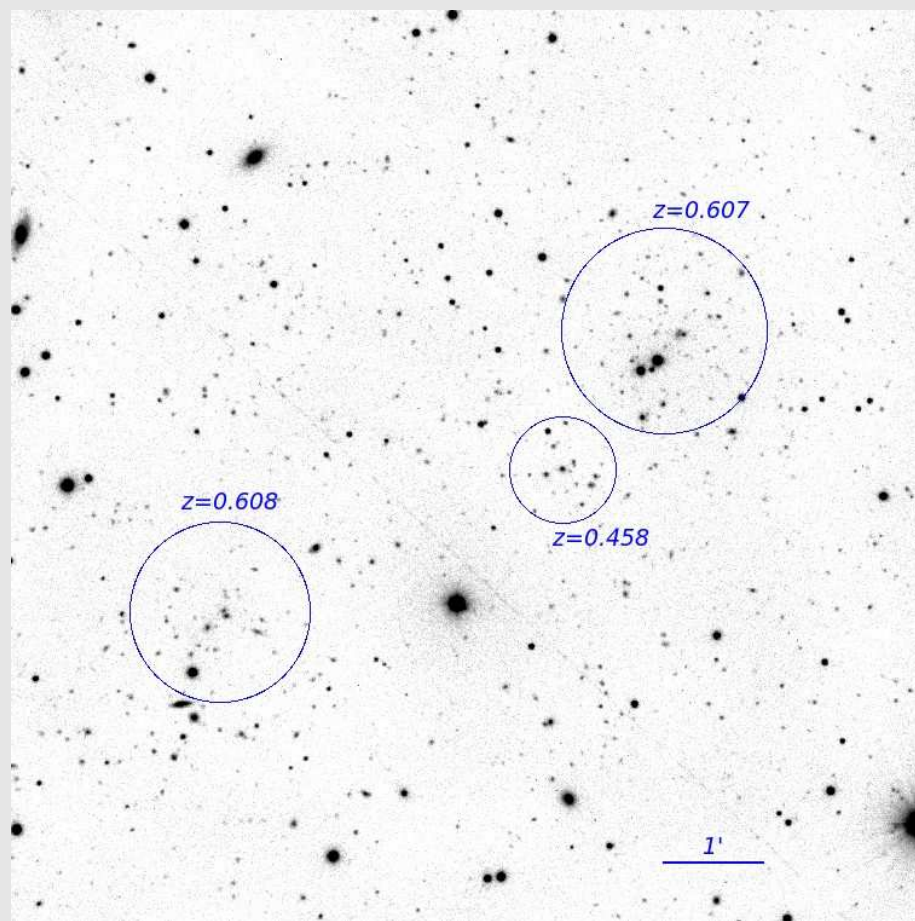
# Fossil groups



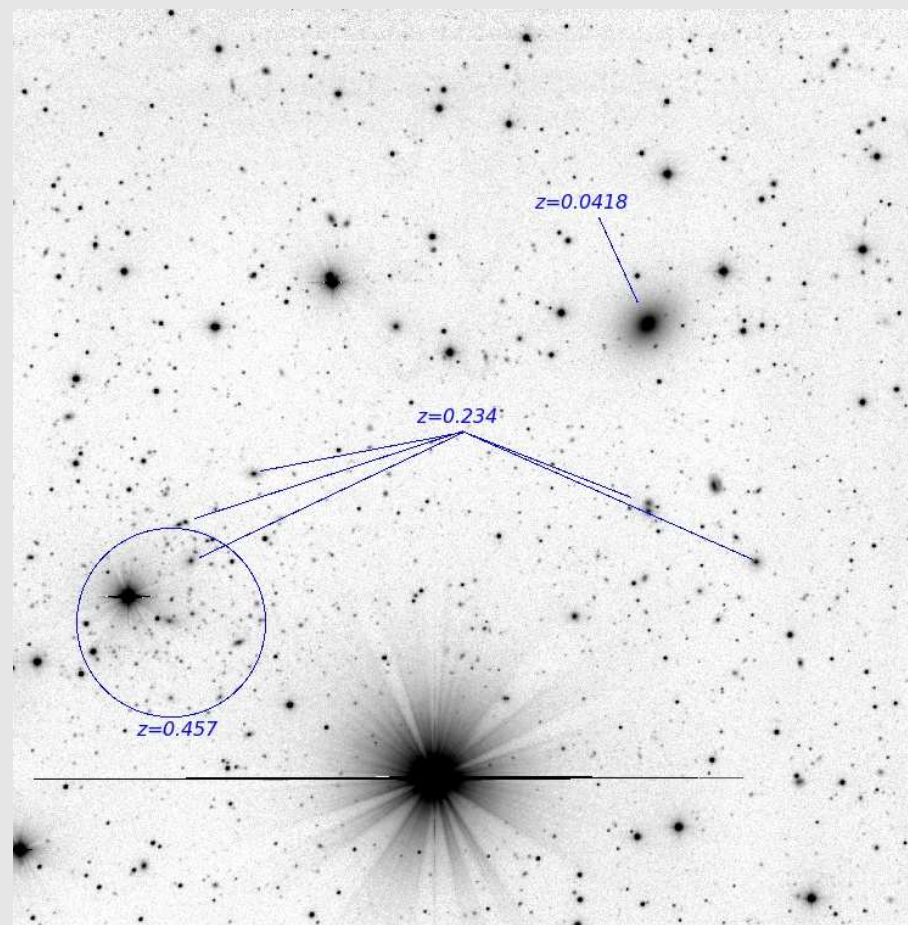
PSZ1 G076.44+23.53,  $z = 0.169$   
fossil group



# Multiple and projected clusters



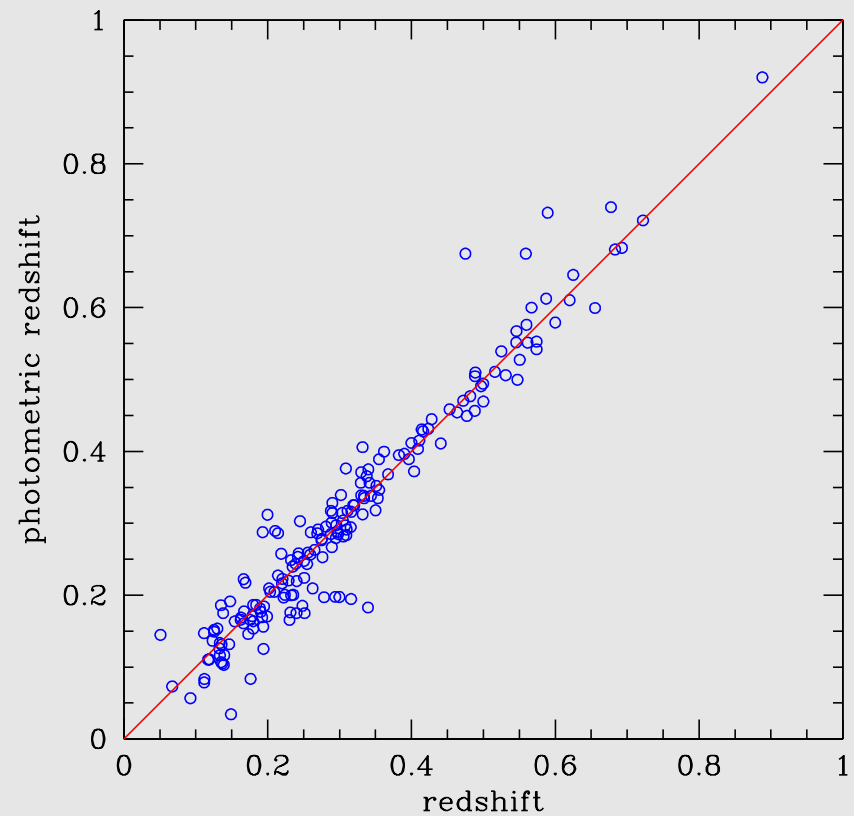
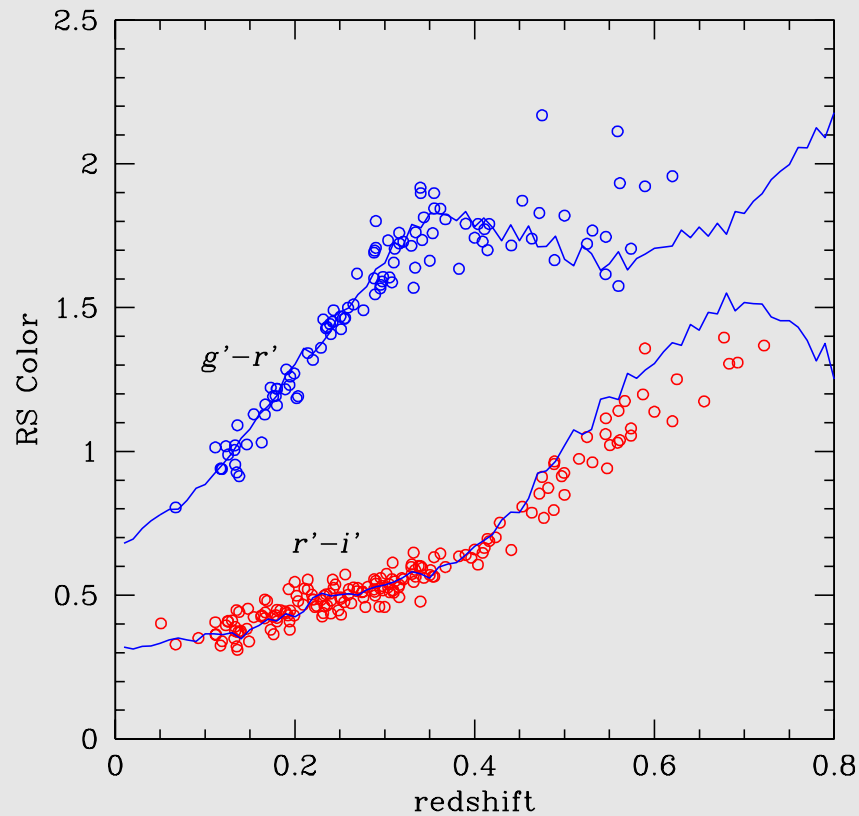
PSZ1 G070.91+49.26



PSZ1 G109.14-28.02

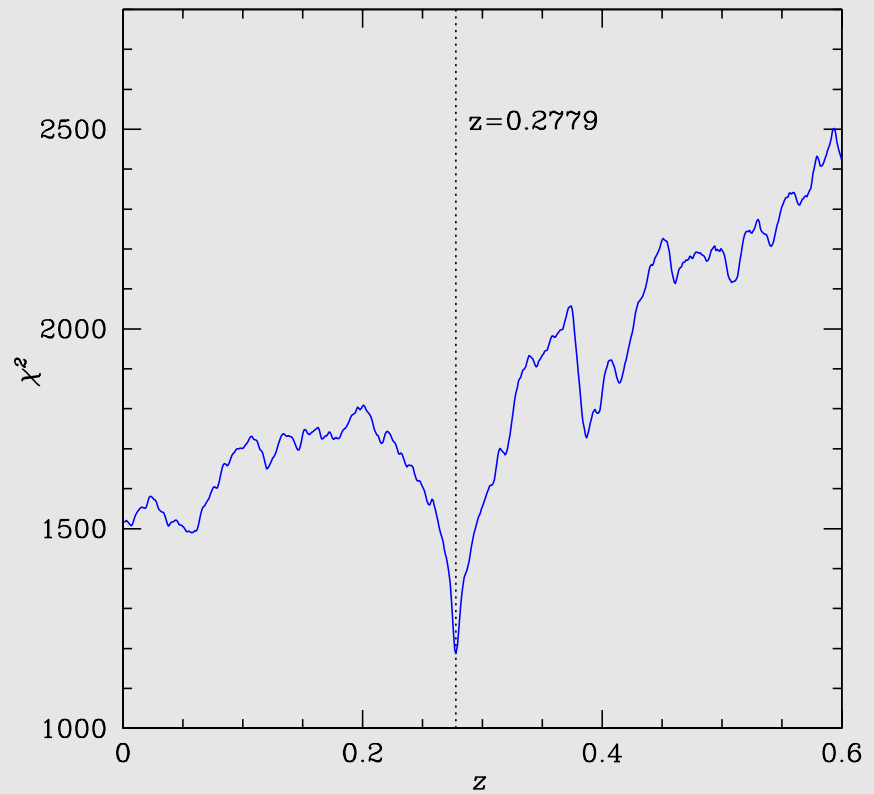
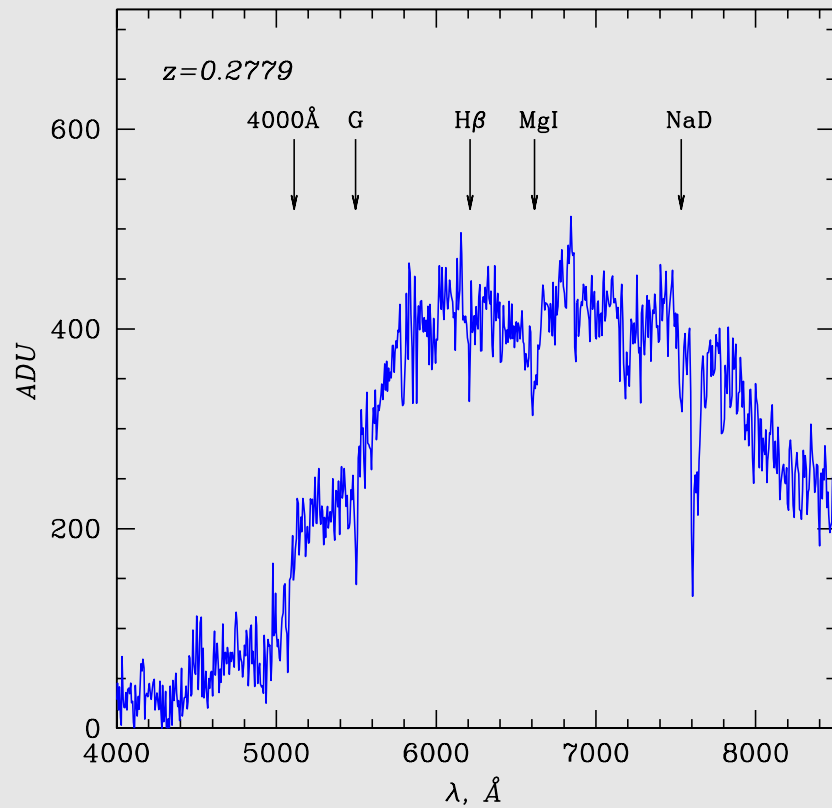
Multiple or projected clusters — 5 out of 47 newly identified clusters, while only  $\approx 3\%$  of clusters are found at  $< 10'$  separation in *400d* and SPT surveys — Planck cluster selection function is affected?

# Photometric redshifts



$\delta z/(1+z) \approx 0.03$ , calibrated using 400d survey data (Burenin et al., 2007)

# Spectroscopic redshifts

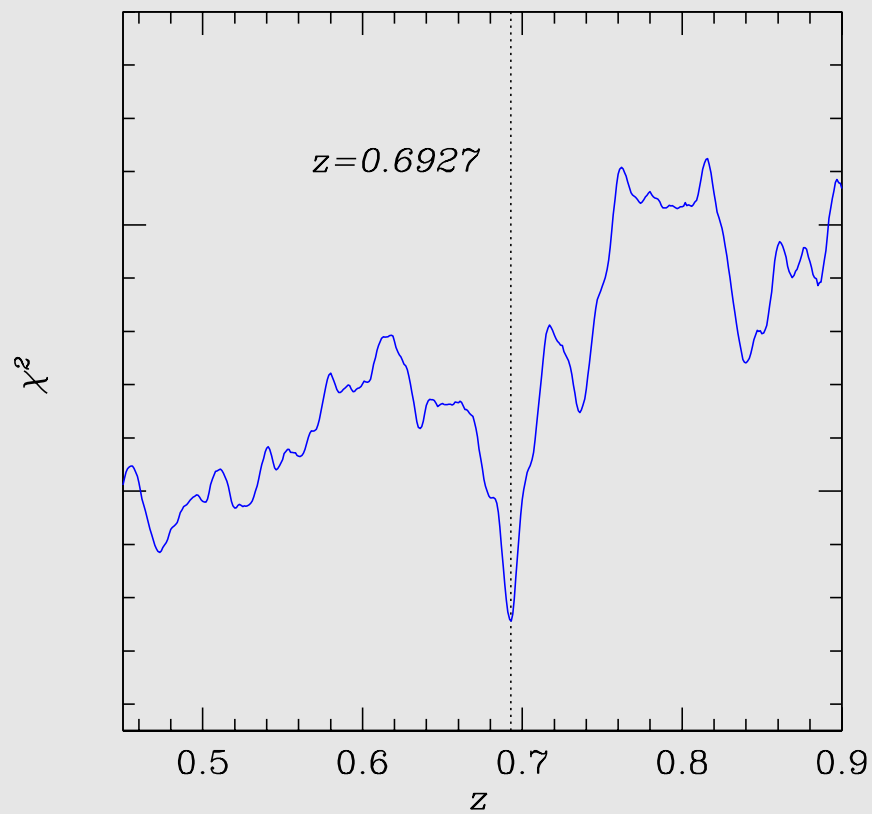
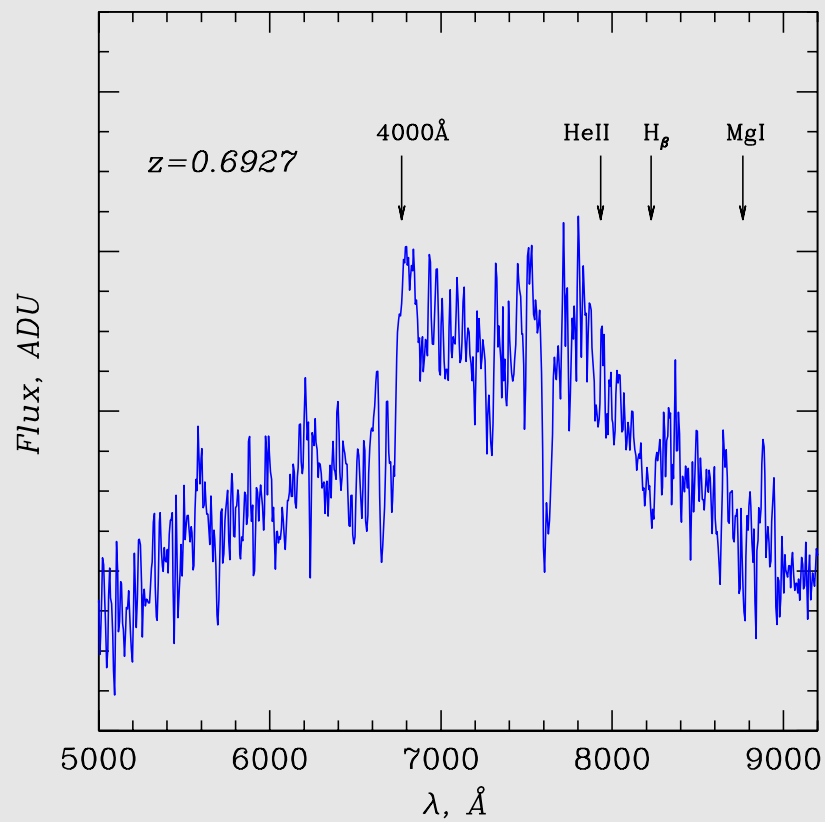


RTT150, 20 min

up to  $z \approx 0.4$



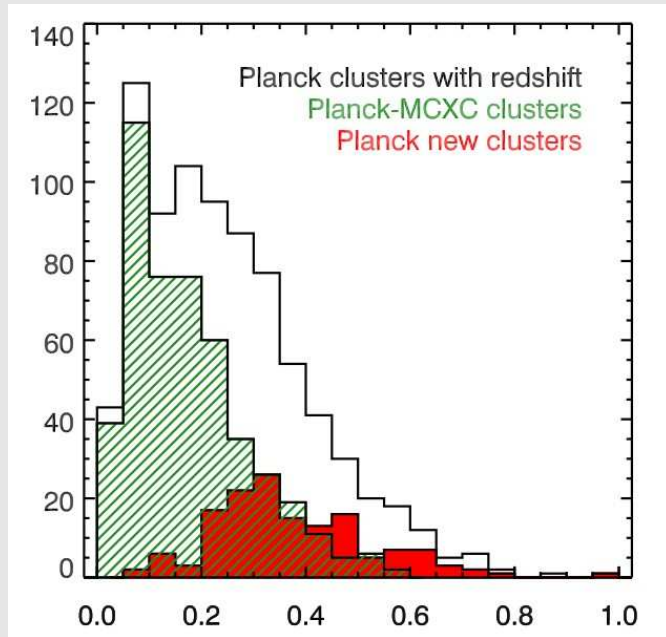
# Spectroscopic redshifts



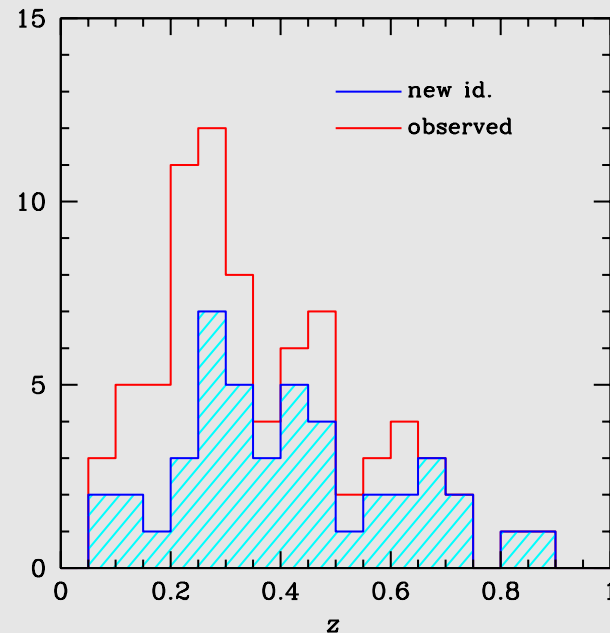
6-m BTA, 30 min

# The number of observed clusters

PSZ1 catalogue:



Observed with RTT:



Observed —  $\approx 130$ , new clusters —  $> 50$ ,  
redshifts measured  $> 60$

SZ sources — 1227,  
to be observed in optical —  $\approx 500$

i.e.  $\approx 20$ – $25\%$  of all required observations

Planck Intermediate Paper, A&A submitted,  
arXiv:1407.6663

# List of telescopes

- IAC80, 0.8-m
- Nordic Optical Telescope, 2.56-m
- Isaac Newton Telescope, 2.54-m
- Gran Telescopio Canarias, 10.4-m
- Telescopio Nazionale Galileo, 3.58-m
- William Herschel Telescop, 4.2-m
- Russian-Turkish Telescope (RTT), 1.5-m
- Bolshoy Telescop Azimutal'ny (BTA), 6-m
- + Calar Alto 2.2-m telescope (recently)
- New Technology Telescope, 3.58-m
- ESO 2.2-m
- Very Large Telescope

— follow-up programme for PSZ1 is almost finished

— follow-up programme for PSZ2 was not started yet (?) . . . may be completed in a few years



## Conclusions

- Optical observations with RTT150 and BTA telescopes provide a significant part of all required observations of Planck SZ sources.
- The programme of optical observations of galaxy clusters from Planck survey can be completed in a few years.