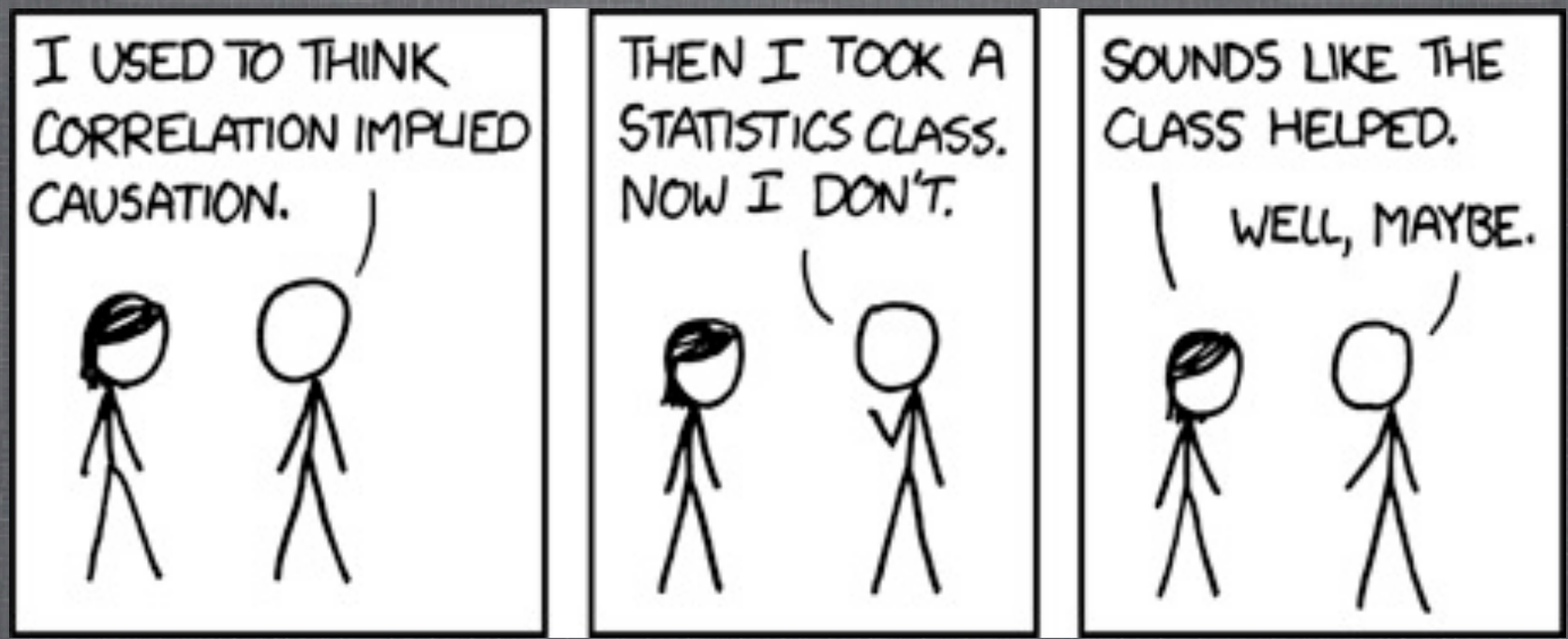
# THE DEATH OF SPECTROSCOPY

IJCAI-09, Pasadena

Adam Myers




http://xkcd.com/552/

(should spectroscopy die it wasn't my fault)

# THE "DEATH OF SPECTROSCOPY" - DISCLAIMER

- With "D.O.S." I'm being a little tongue-in-cheek
  - I point this out for safety reasons because I, myself, nearly killed a professor, ~2 months from retirement, last time I used this phrase
- I don't really believe spectroscopy will be phased out completely. It will always be useful for certain projects
  - Alex, George, Alex insisted on gross speculation, though...and as I'm a statistical cosmology guy, my perspective in this talk is ***LARGE*** projects
- So, then...there are some major potential suspects in the recent, ongoing spectroscopy murders

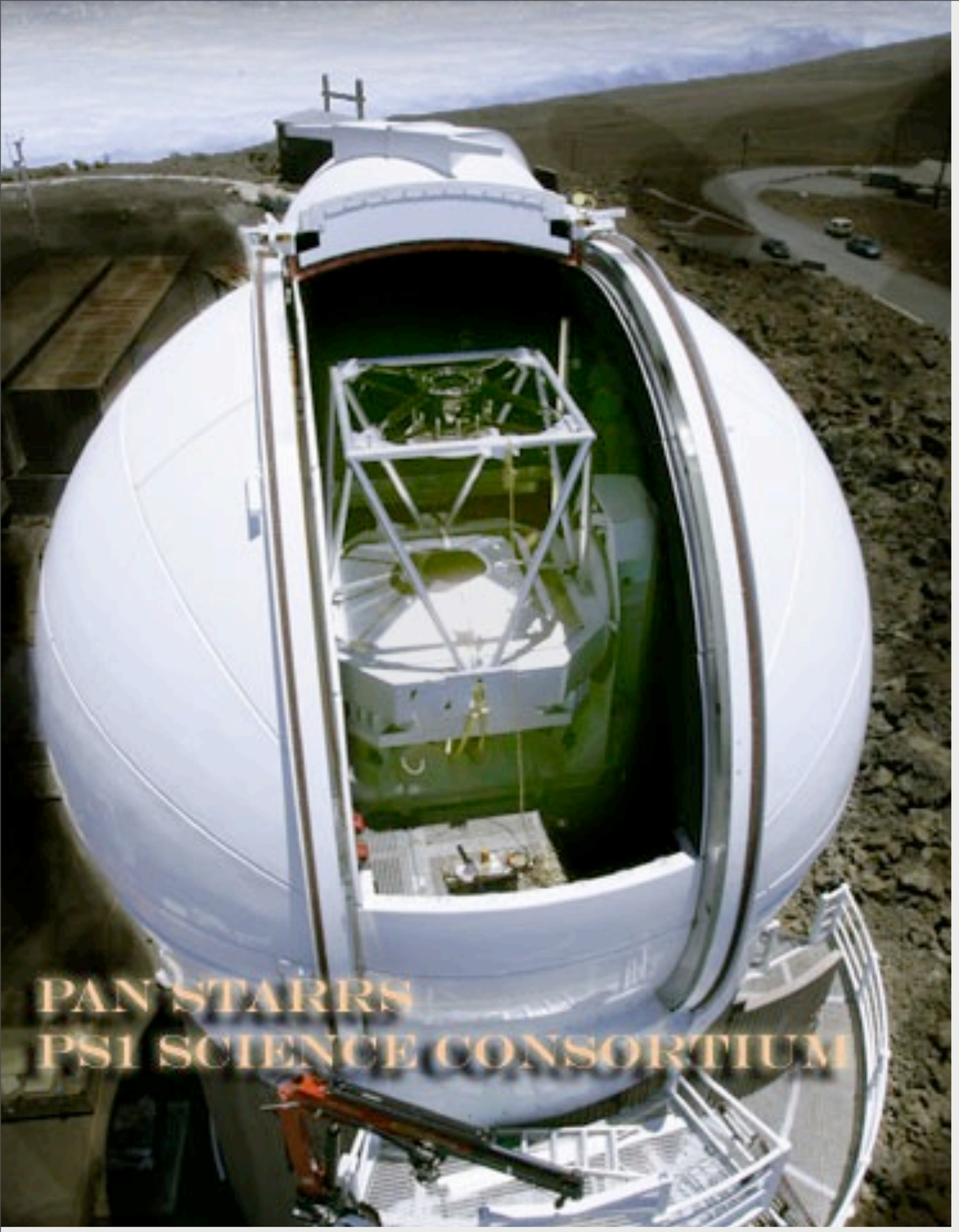



Photo: Brett Simpson

# SOME SUSPECTS...

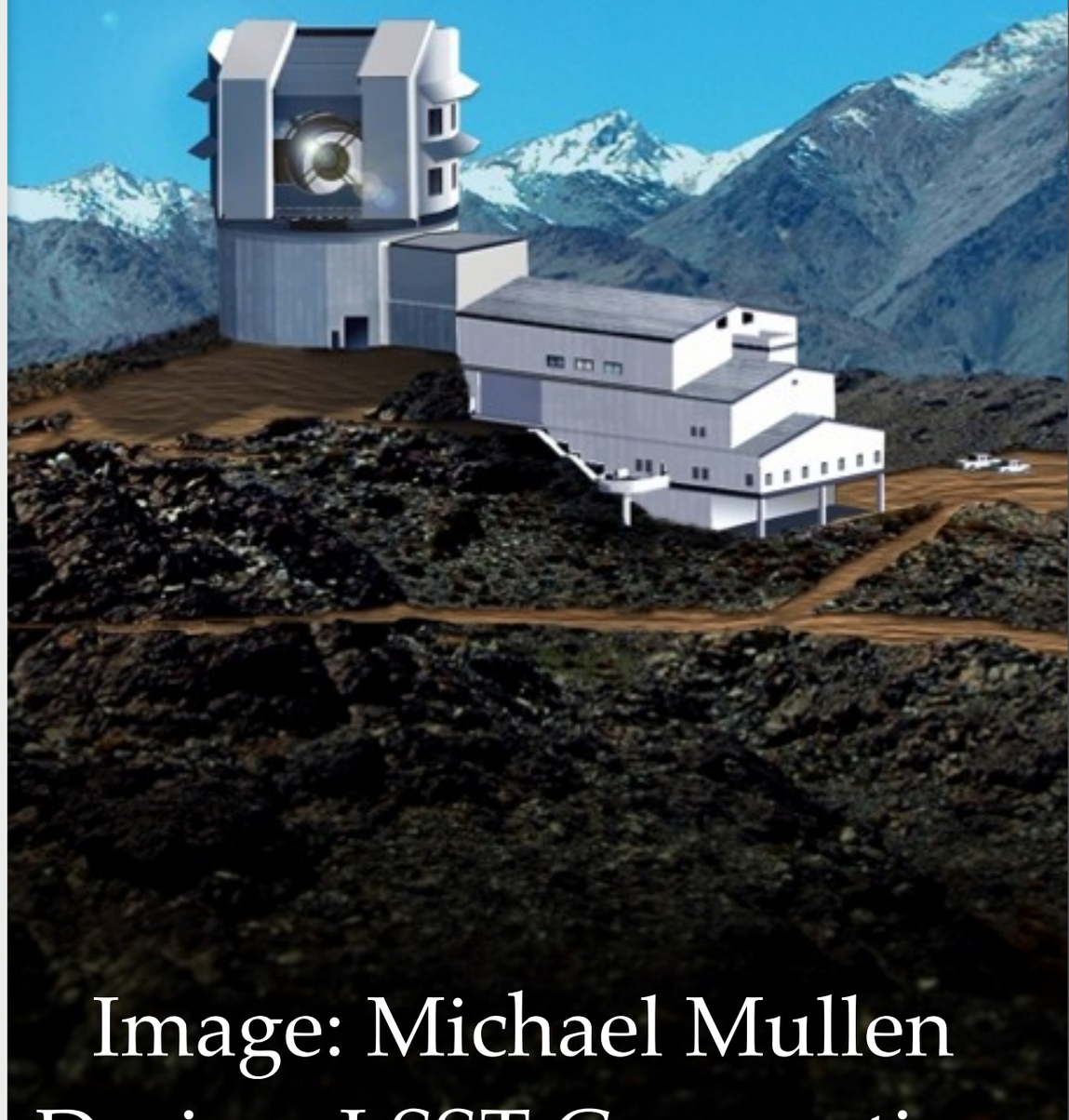


Image: Michael Mullen
Design, LSST Corporation

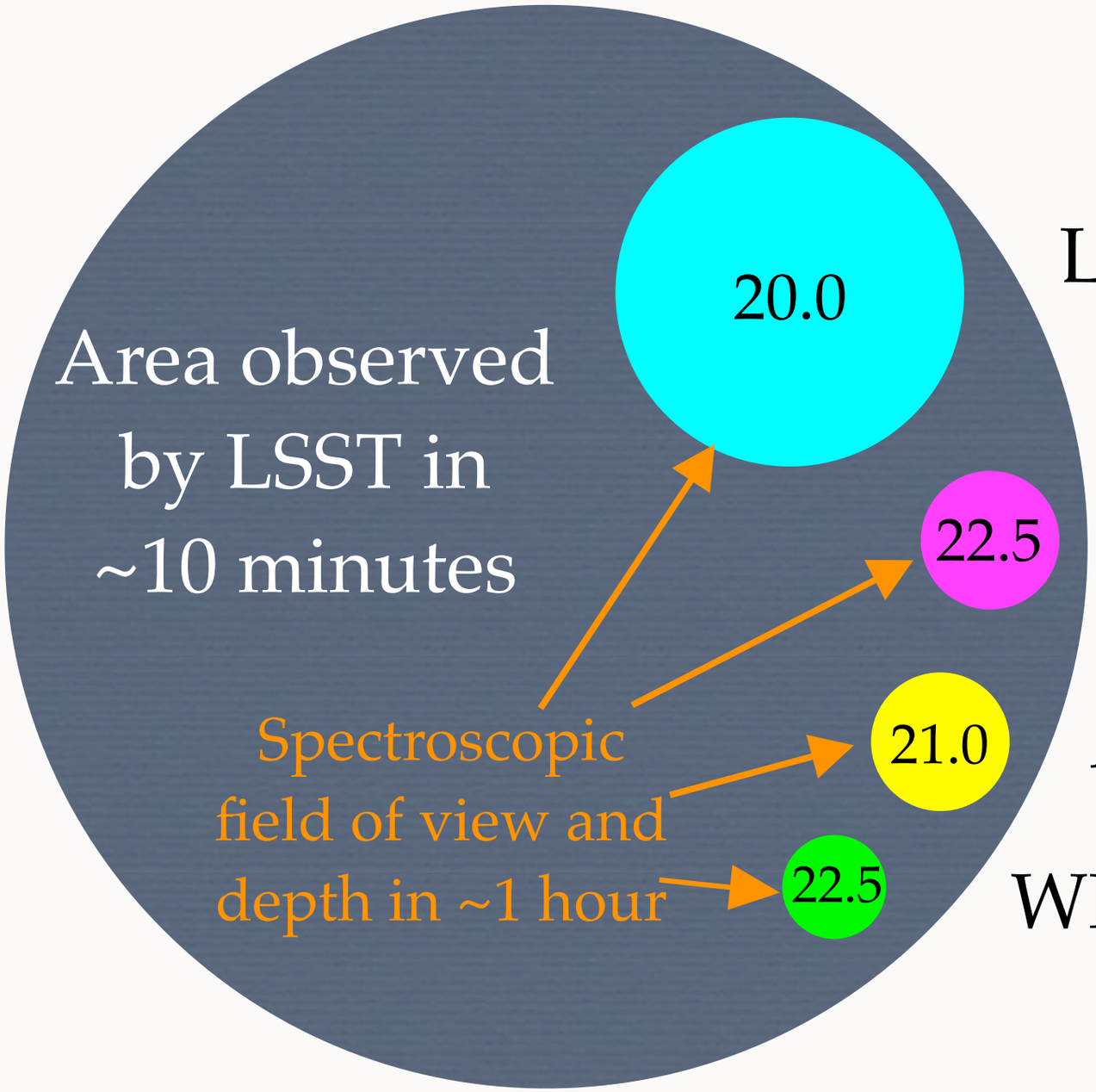
# THE DEATH OF SPECTROSCOPY - SUSPECTS

- Pan-Starrs
  - Survey area equivalent to entire sky to magnitude ~23 in about a week
- LSST
  - Survey area equivalent to entire sky to magnitude ~24 twice a week
- LSST, Pan-STARRS, DES, VST, VISTA have no spectroscopic components
  - During his conference summary talk at the wrap-up symposium, SDSS Project Scientist, Jim Gunn, called this a “dreadful, dreadful” mistake

# THE DEATH OF SPECTROSCOPY - SUSPECTS

- So what is our spectroscopic equivalent of these large-field and/or drift-scan surveys?
- WFMOS?
  - Could reach depths consistent with LSST, m~24 is realistic
- LAMOST?
  - ~20 sq. deg. field of view. Could tile entire sky in ~2500 fields

# SPECTROSCOPY OF THE NEXT-GENERATION PHOTOMETRIC SURVEYS




LAMOST

KAOS on Subaru*

AAΩ

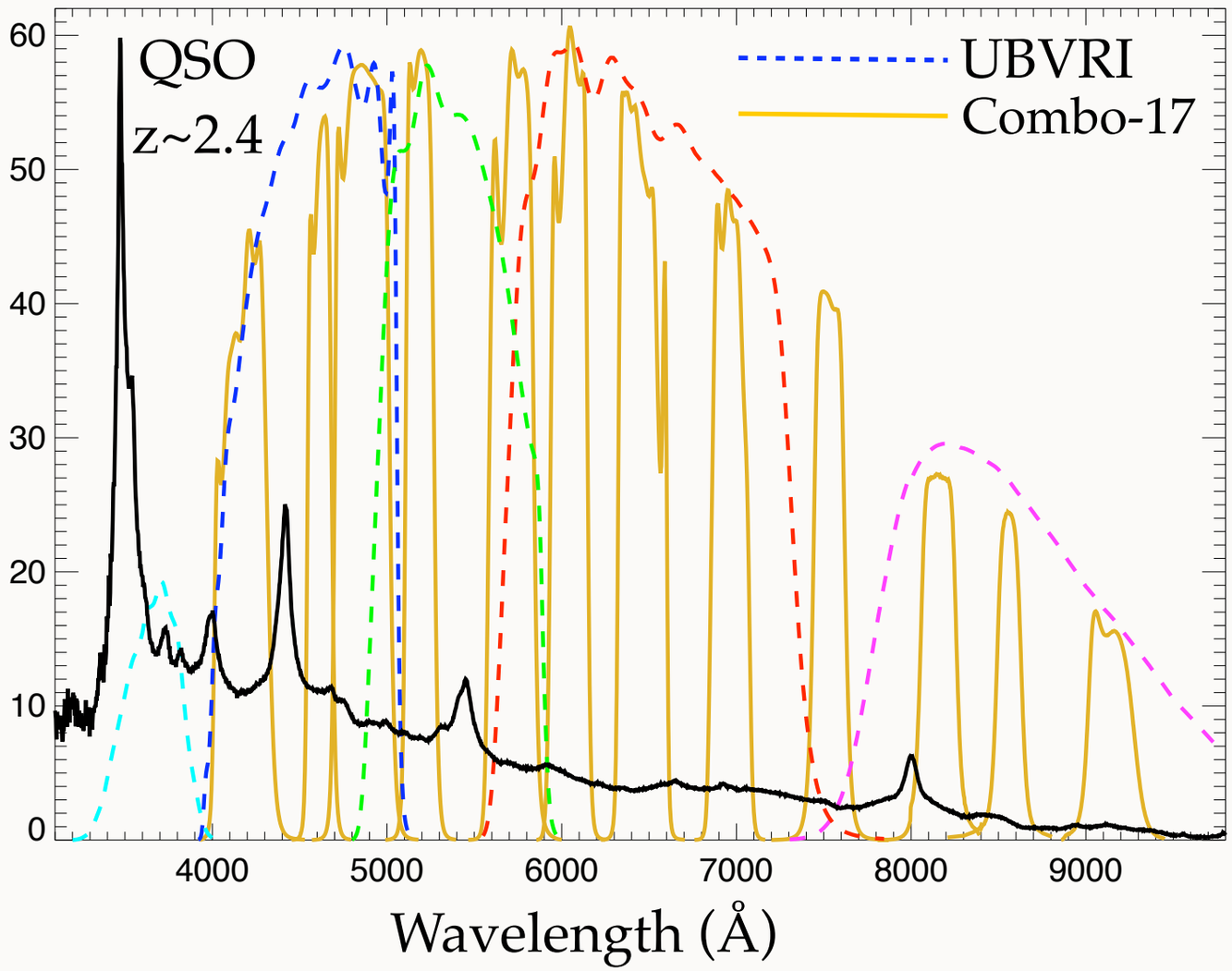
WFMOS on Gemini*

*proposed

# THE DEATH OF SPECTROSCOPY

- WFMOS?
  - Could maybe tile entire sky to ~22.5 in ~8 years of **perfect** observations
- LAMOST?
  - Could maybe tile entire sky to ~22 in ~6 years of **perfect** observations
- LSST
  - Entire sky to ~23 every few days
- Spectroscopy will fall behind. Photometry is king

# THE DEATH OF SPECTROSCOPY - SHOULD WE CARE THAT IT'S GONE?




Clearly there are things that only spectroscopy can tell us (it contains useful additional information)...

...but just as clearly spectroscopy is *always overkill* (it always contains useless information)

# TECHNIQUES - THE TIME DOMAIN HAS SOME UNEXPECTED BENEFITS

- LSST, Pan-STARRS etc. won't have a resolution comparable to 12 narrow filters (COMBO-17)
- The time domain helps in unexpected ways, though
- For instance, due to atmospheric refraction, different airmass observations shift your filter set slightly
- High airmass observations can be equivalent to having different filters (Richards et al. 2009)!

# DISCUSSION POINTS...

One thing I think it would be useful to discuss is what we can and can't do at a cosmologically useful level using just multi-epoch photometry (and how might we look at measuring these things from photometry)

- classifications ✓
- redshifts ✓
- halo masses ✓
- stellar light content vs accretion light content ?
- black hole masses ?
- accretion rates ?
- star formation rates ?

# CAN WE REAP NEW INFORMATION FROM NEW TECHNIQUES?

So. Photometry is king. What cosmological *techniques* currently utilize statistical photometric information?

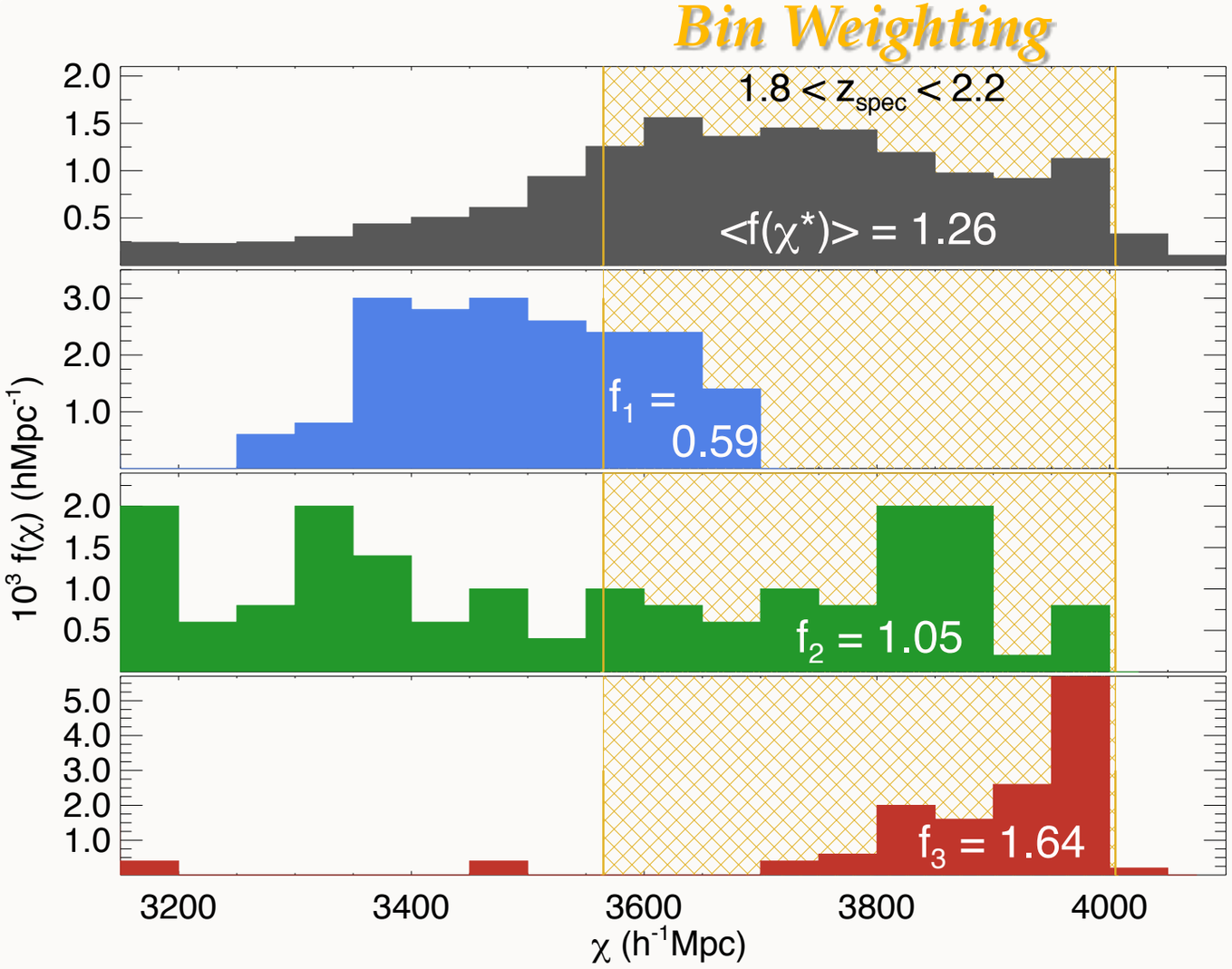
- Red Cluster Sequence (Gladders, Yee etc. van Breukelen, Clewley)
- Some Luminosity Function techniques (Subbarao, Koo, Connolly, Szalay, etc., Chen, Sheth)
- Some clustering techniques (Connolly, Szalay, Brunner, etc. Myers, Richards, Nichol)

# CAN WE REAP NEW INFORMATION FROM NEW TECHNIQUES?

But what cosmological techniques currently utilize *probabilistic* statistical photometric information?

- A lot of cosmological techniques simply use large numbers of objects just to beat down the errors
- I'd argue that many of them take first-order numbers, i.e., "a photometric redshift" and don't really take account of the full probabilistic classification information
- But statistical techniques usually come with a fuller set of information...

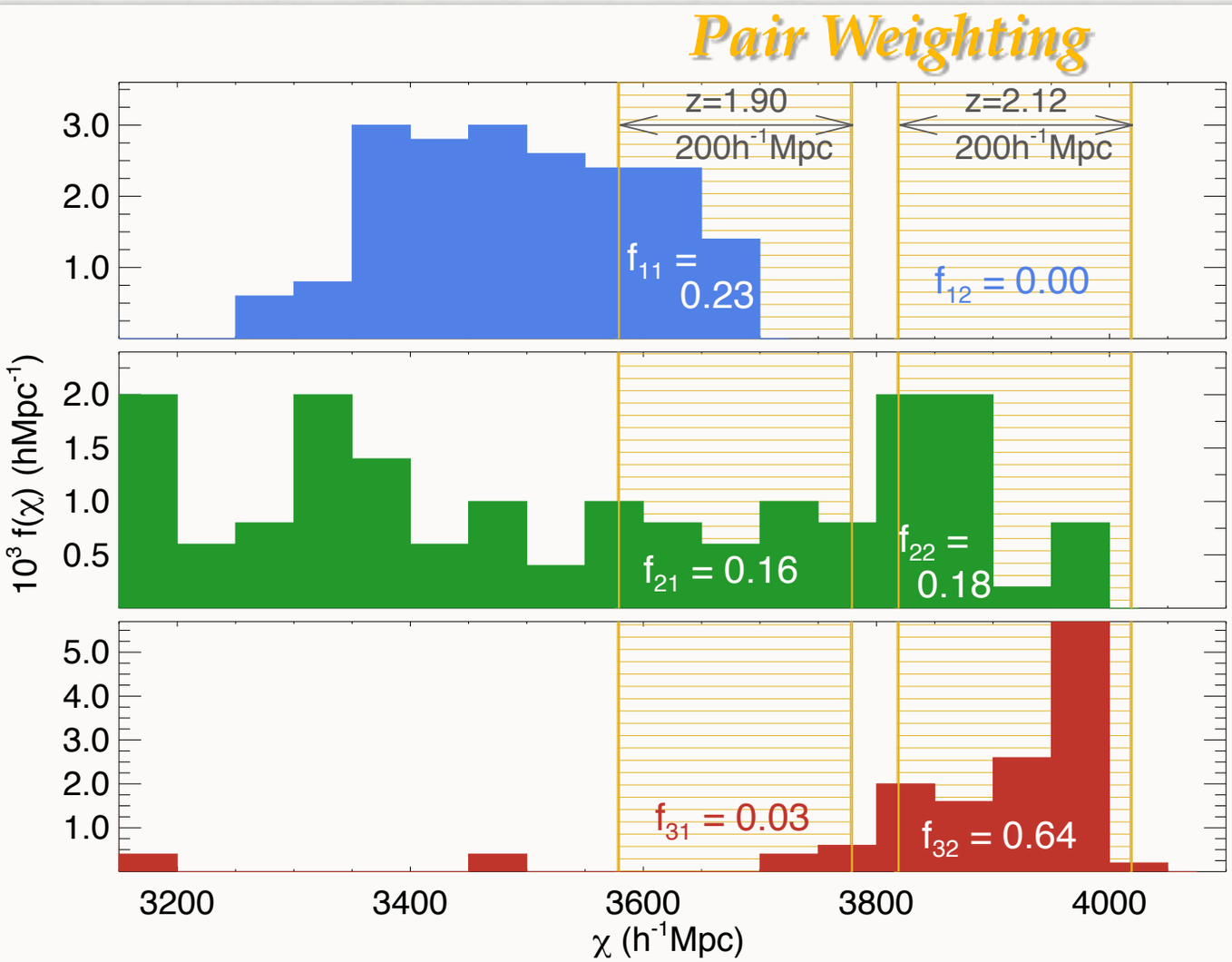
# NEW TECHNIQUES - SIMPLE EXAMPLE (NOT A PLUG..NO ROTTEN VEGETABLES)




As an illustration of utilizing full probabilistic information. Consider the top panel ($\sum_{i=1}^{n} f_i$ photometric redshift pdfs in the range $1.8 < z < 2.2$) and the bottom three panels ($f_1, f_2, f_3 \ldots f_n$ individual pdfs)

The $f$ weights are calculated by the (comoving) overlap of the pdf and the bin $1.8 < z < 2.2$ (which contains spectroscopic objects)

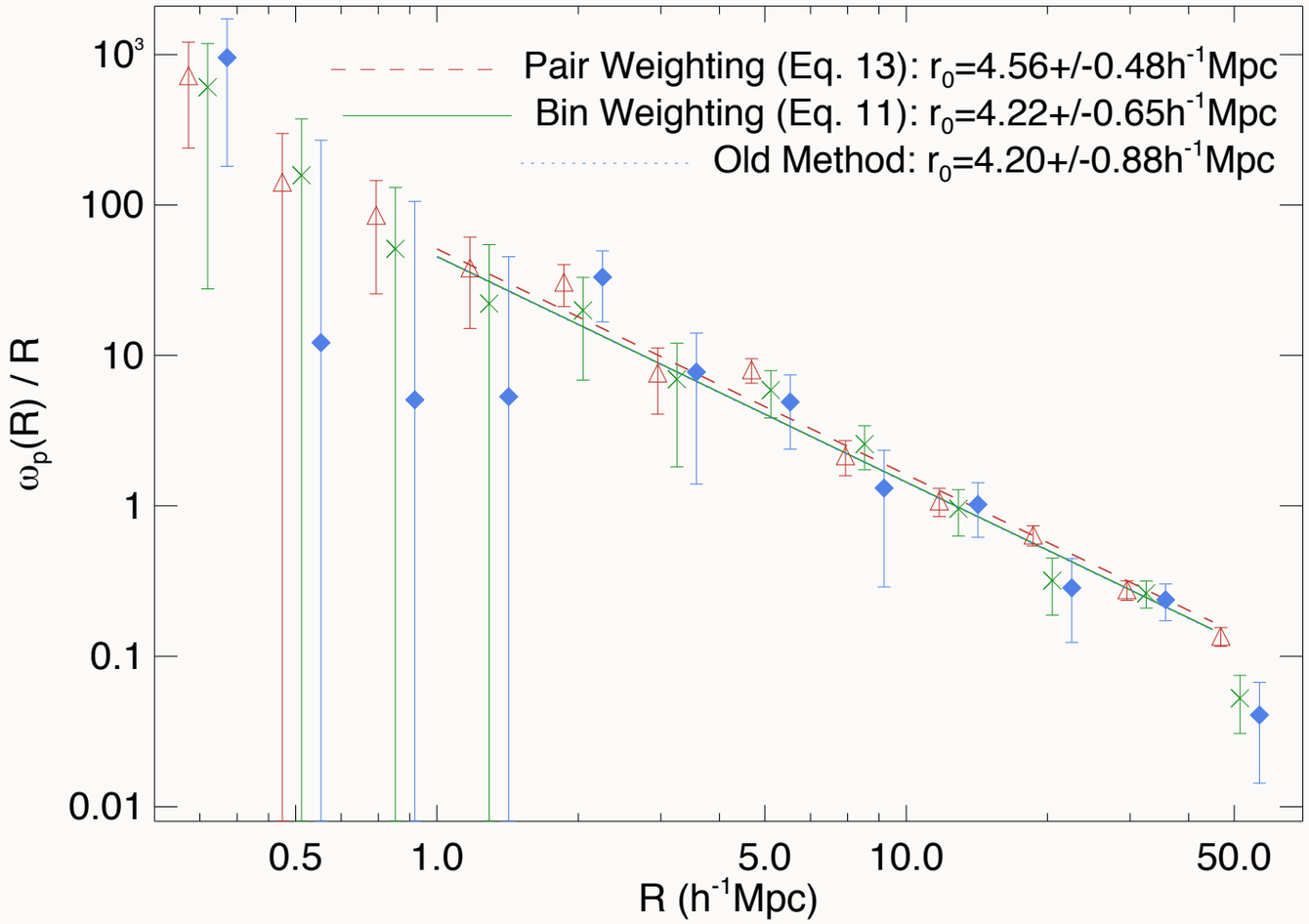
# NEW TECHNIQUES - SIMPLE EXAMPLE




We can take such a weight scheme a step further...

The ***f*** weights *here* are calculated by the (comoving) overlap of the pdf and windows placed around *individual* spectroscopic objects

# NEW TECHNIQUES - SIMPLE EXAMPLE




Measure clustering using the full weights (rather than just equal weights improves clustering signal by a factor of **4.2x** with no additional information. At least for QSOs in the SDSS

i.e. use of the probabilities is equivalent to making the SDSS (nearly) an all-sky survey. And even here we don't use all of the information (e.g., we use redshift probabilities but not classification probabilities)

# THE DEATH OF SPECTROSCOPY - CHALLENGES

- Photometry is outpacing spectroscopy
- It's not necessarily clear yet what physical quantities we can measure with photometry alone. Discuss
  - The time domain can help recover spectroscopic information in unexpected ways (i.e. high airmass observations)
  - Trust...will the community believe us, anyway?
- There are clever statistical techniques out there to improve signal using extra photometric information and we've only skimmed the surface...