# *Quasar Target Selection Method in the era of large spectroscopic surveys*

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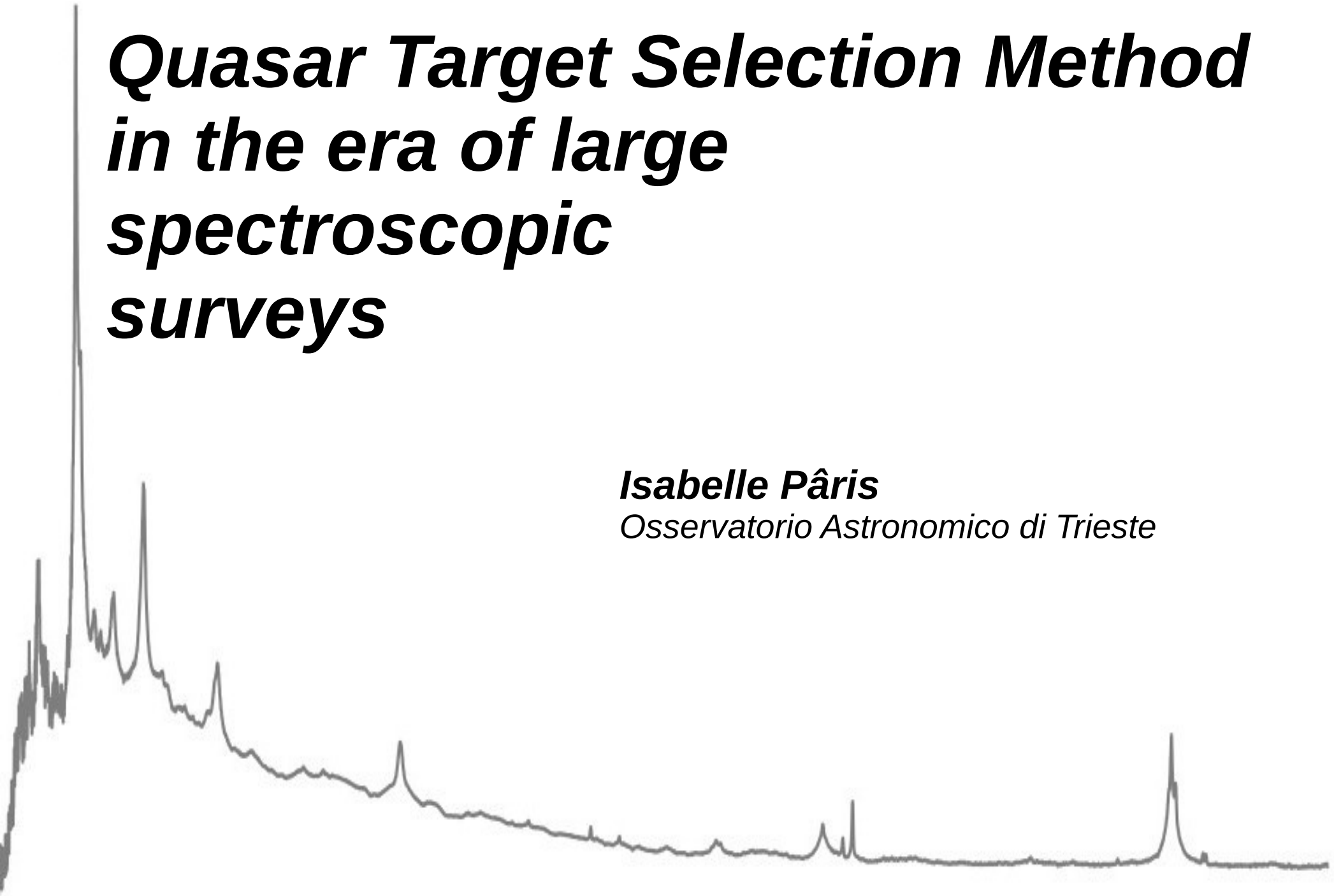
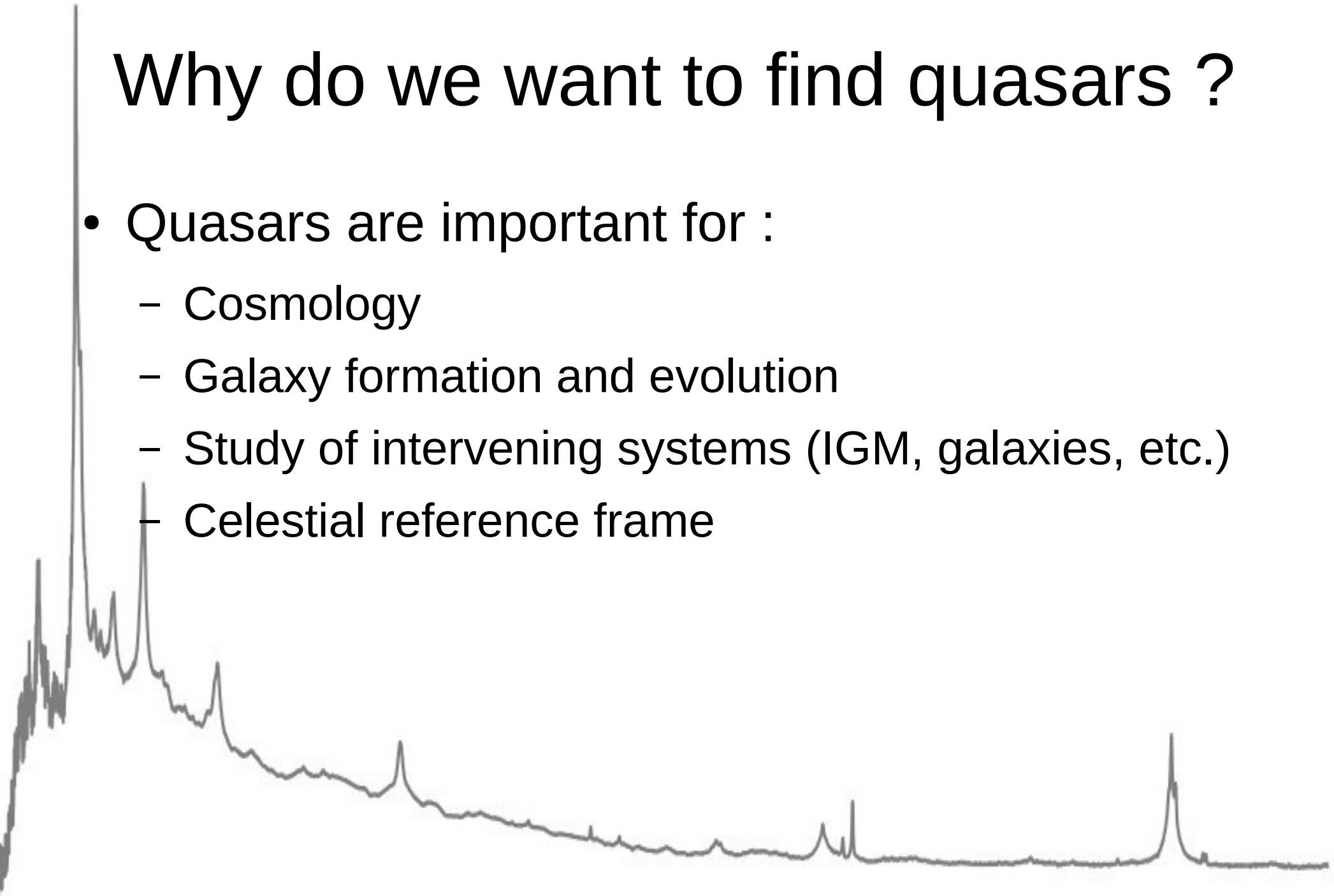
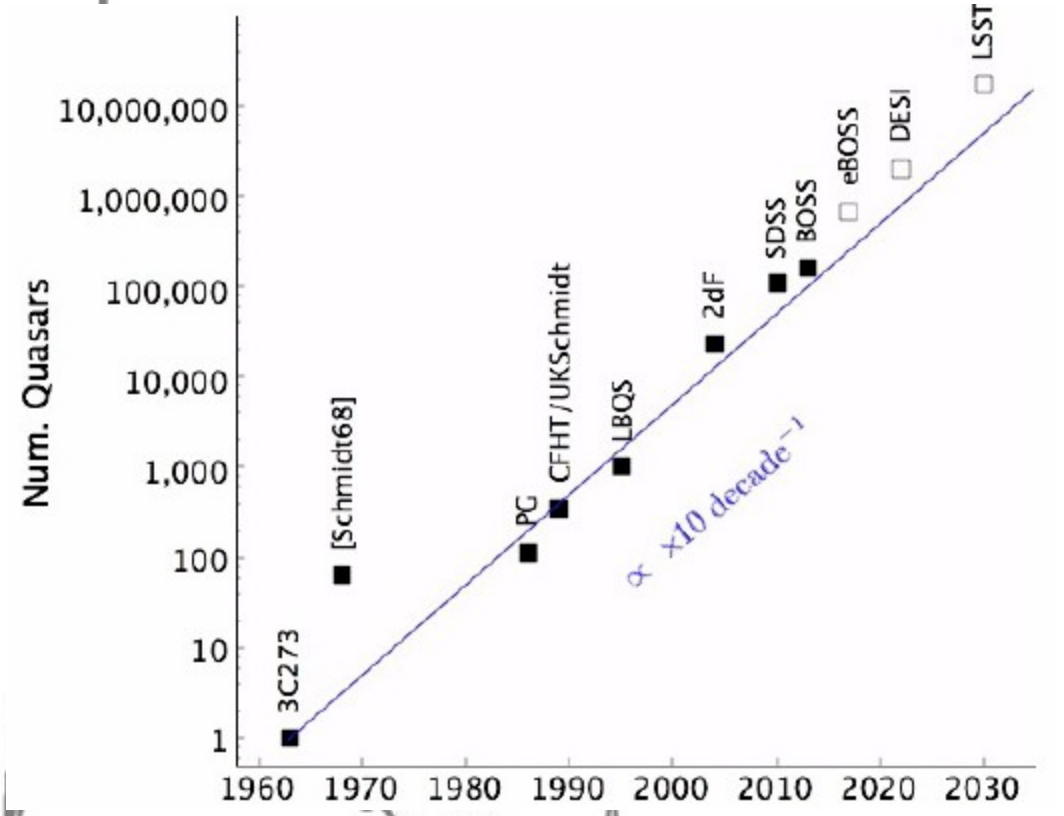


# Why do we want to find quasars ?

- Quasars are important for :
  - Cosmology
  - Galaxy formation and evolution
  - Study of intervening systems (IGM, galaxies, etc.)
  - Celestial reference frame



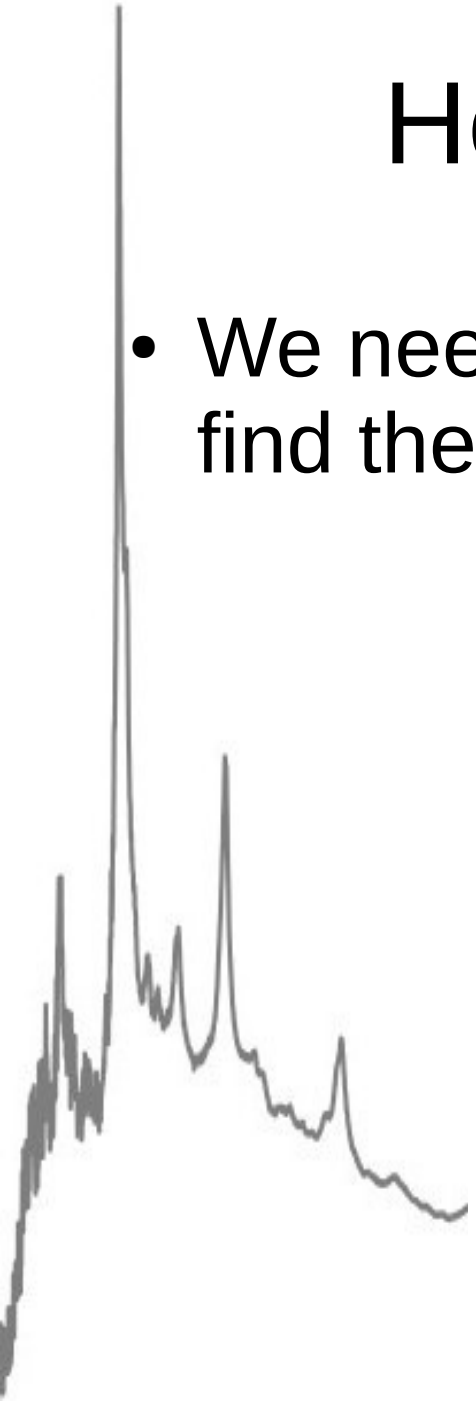
# How many quasars do we know ?

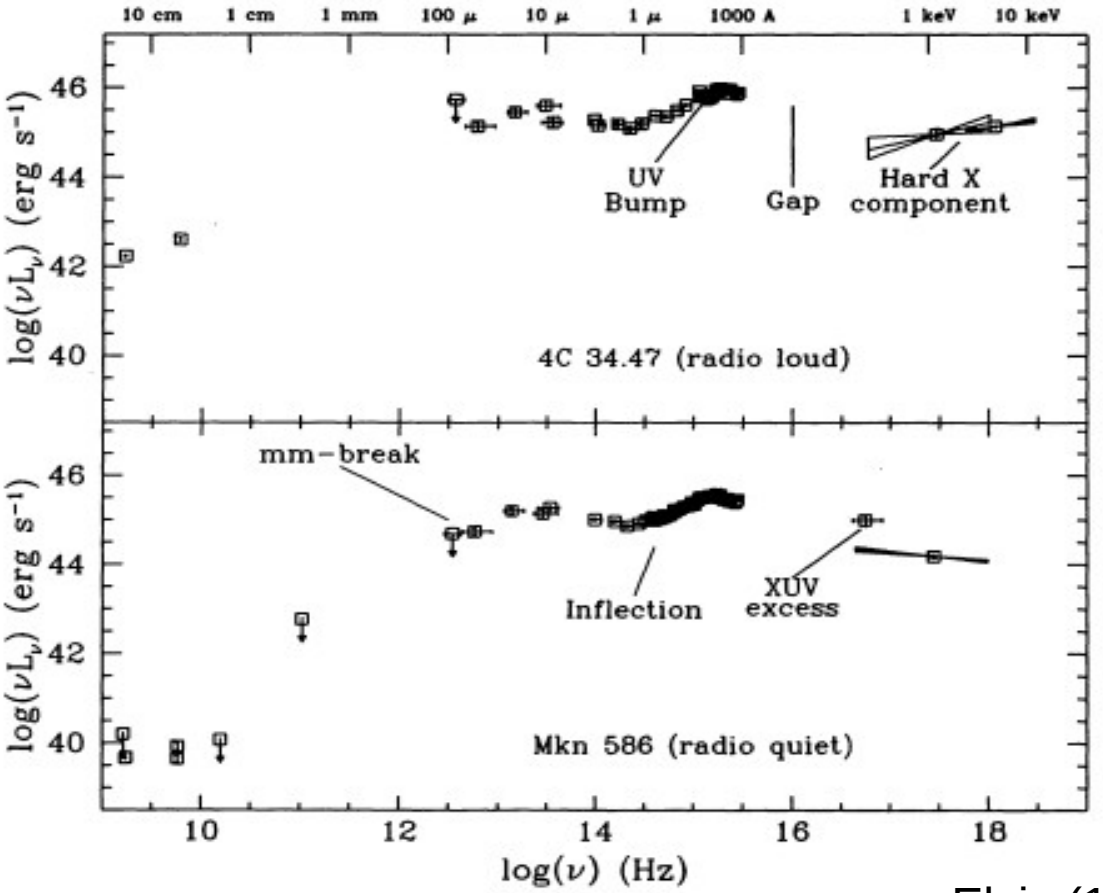


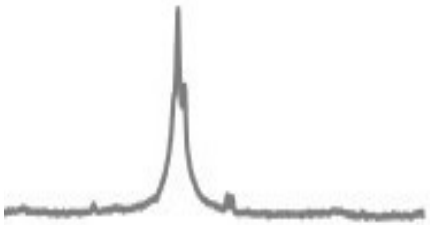

- >5x10$^5$ known quasars since their discovery
- Target selection algorithms evolved a lot !
- We require more and more efficient QTS algorithms

# How do we find quasars ?

- We need to understand quasar properties to find them !



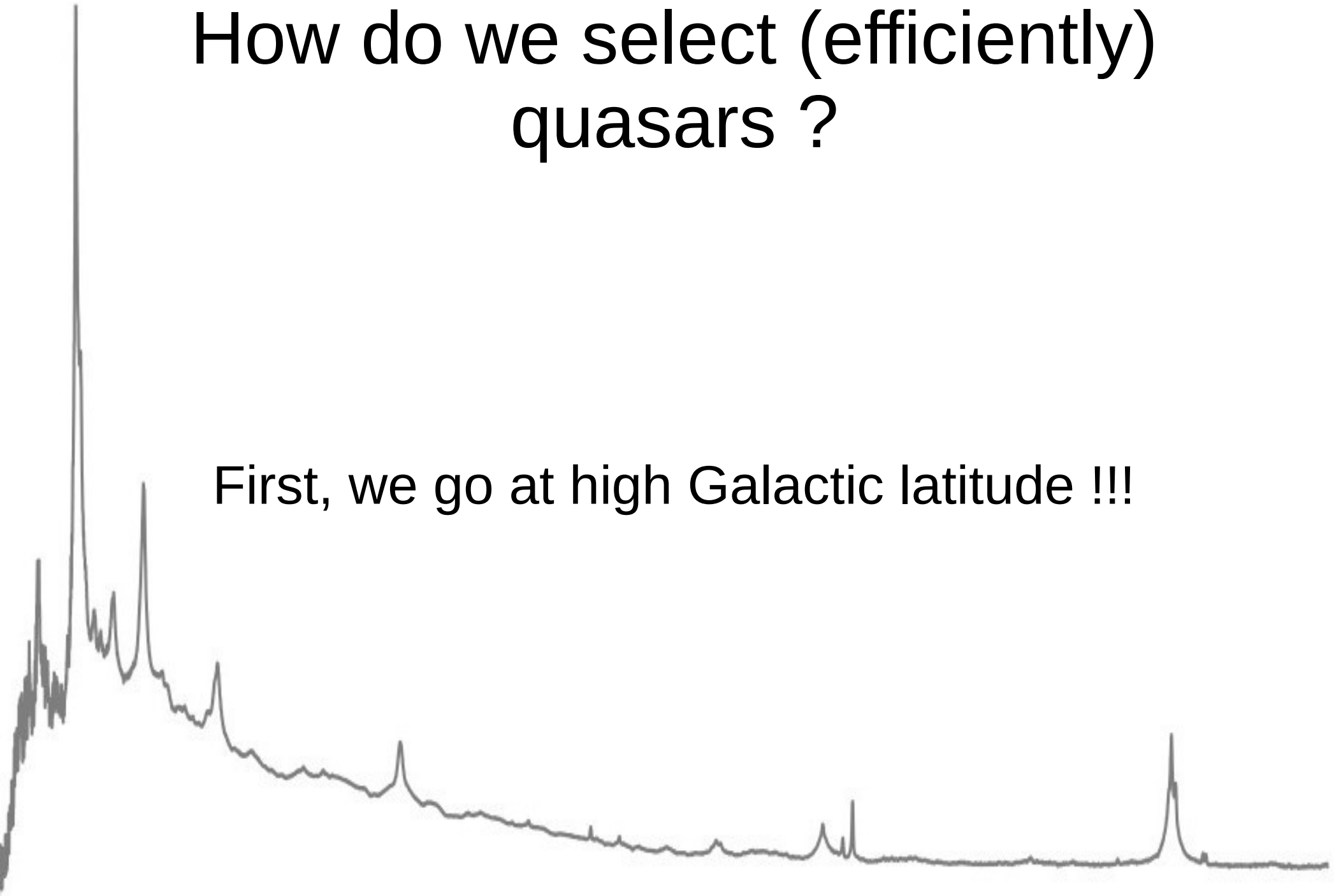


Elvis (1994)

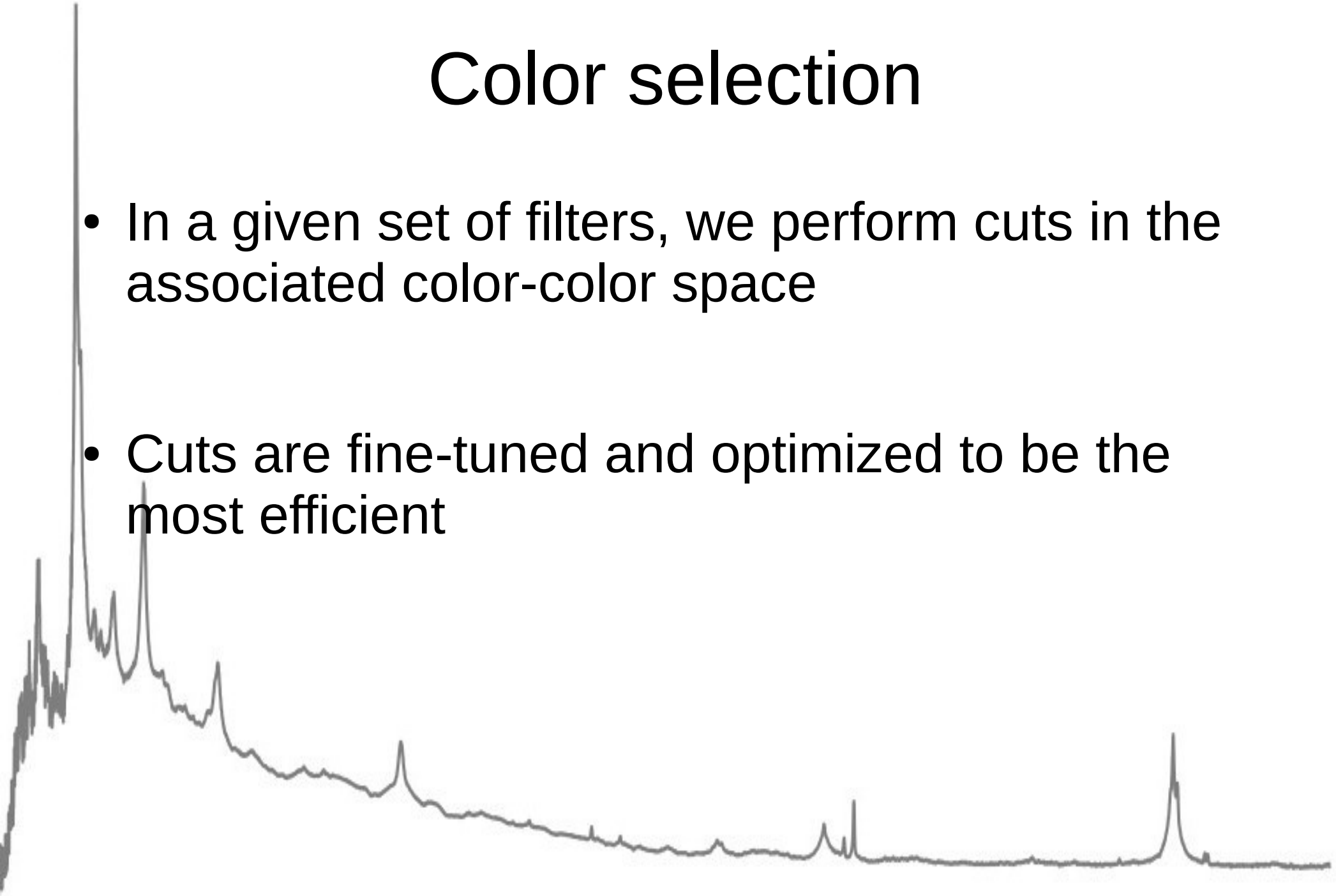
# How do we select (efficiently) quasars ?

First, we go at high Galactic latitude !!!

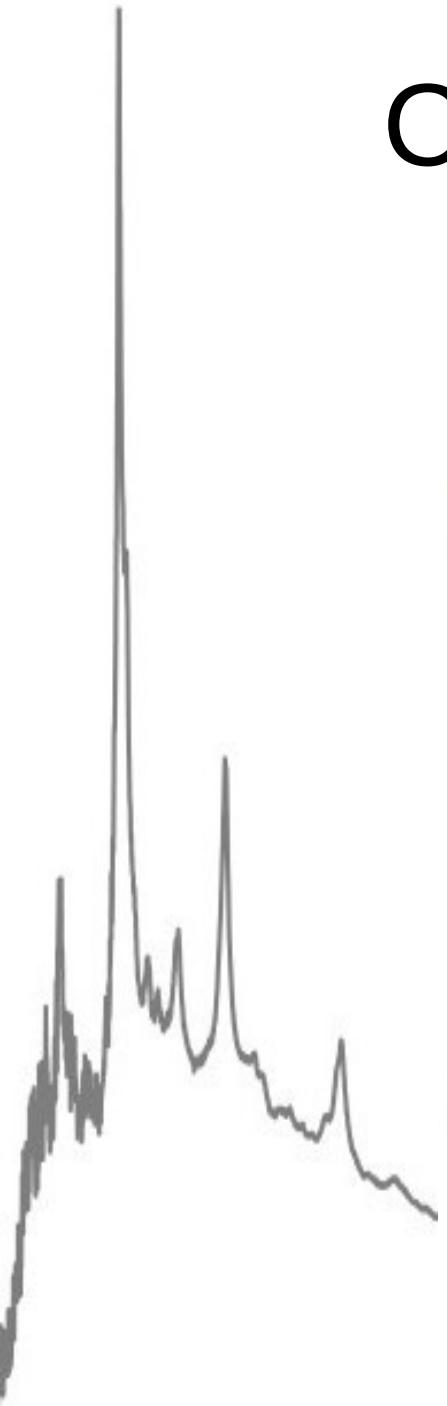


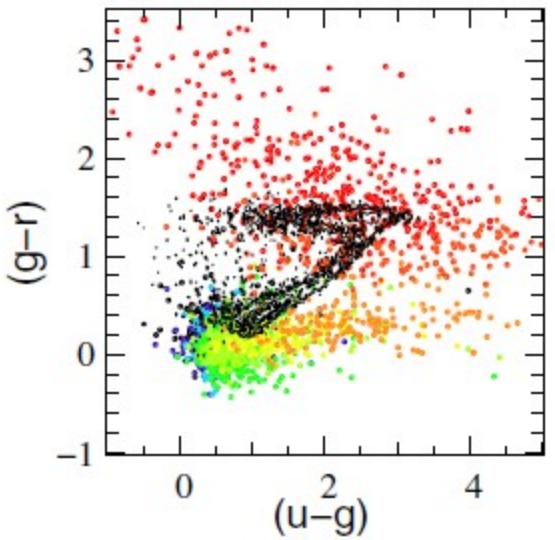
# Color selection

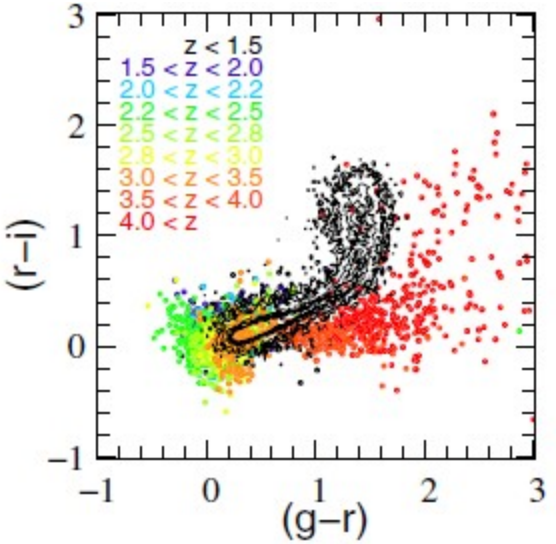
- In a given set of filters, we perform cuts in the associated color-color space
- Cuts are fine-tuned and optimized to be the most efficient

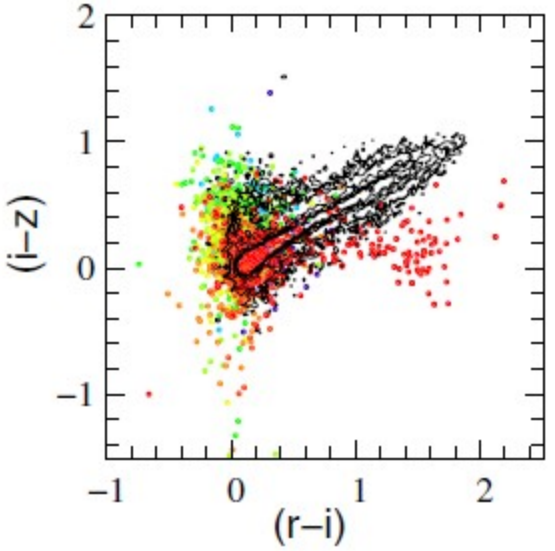


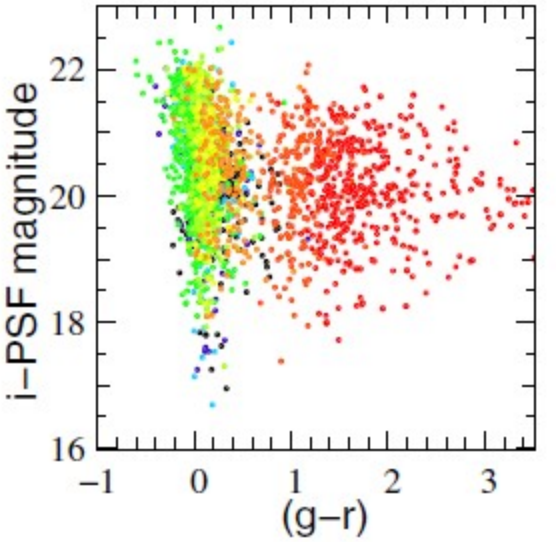
# Color selection (in optical)

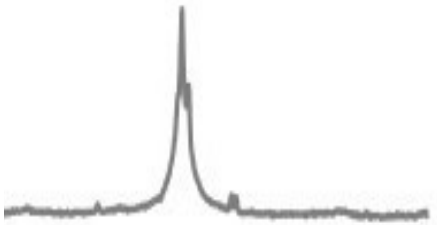




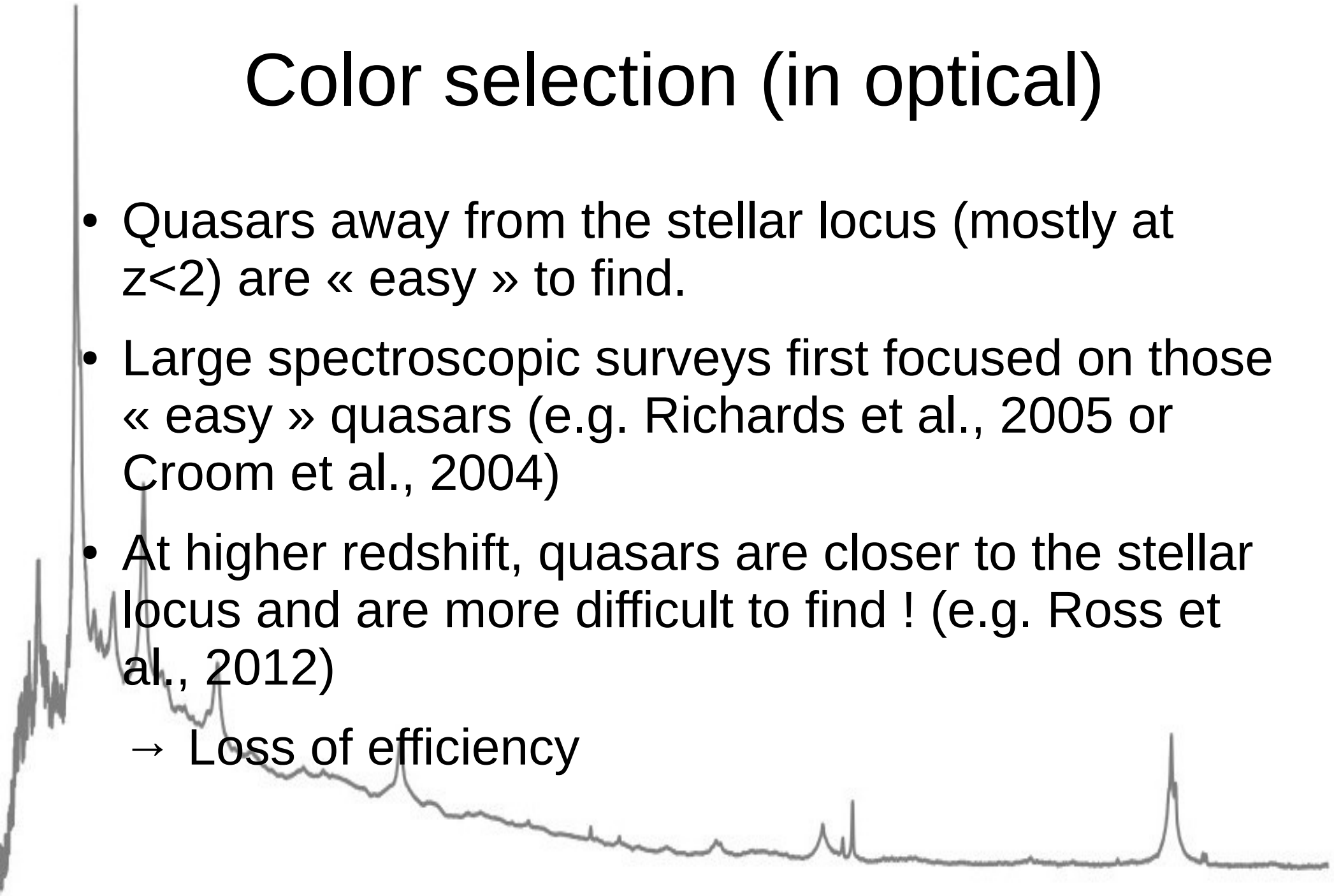



Pâris et al. (2012)

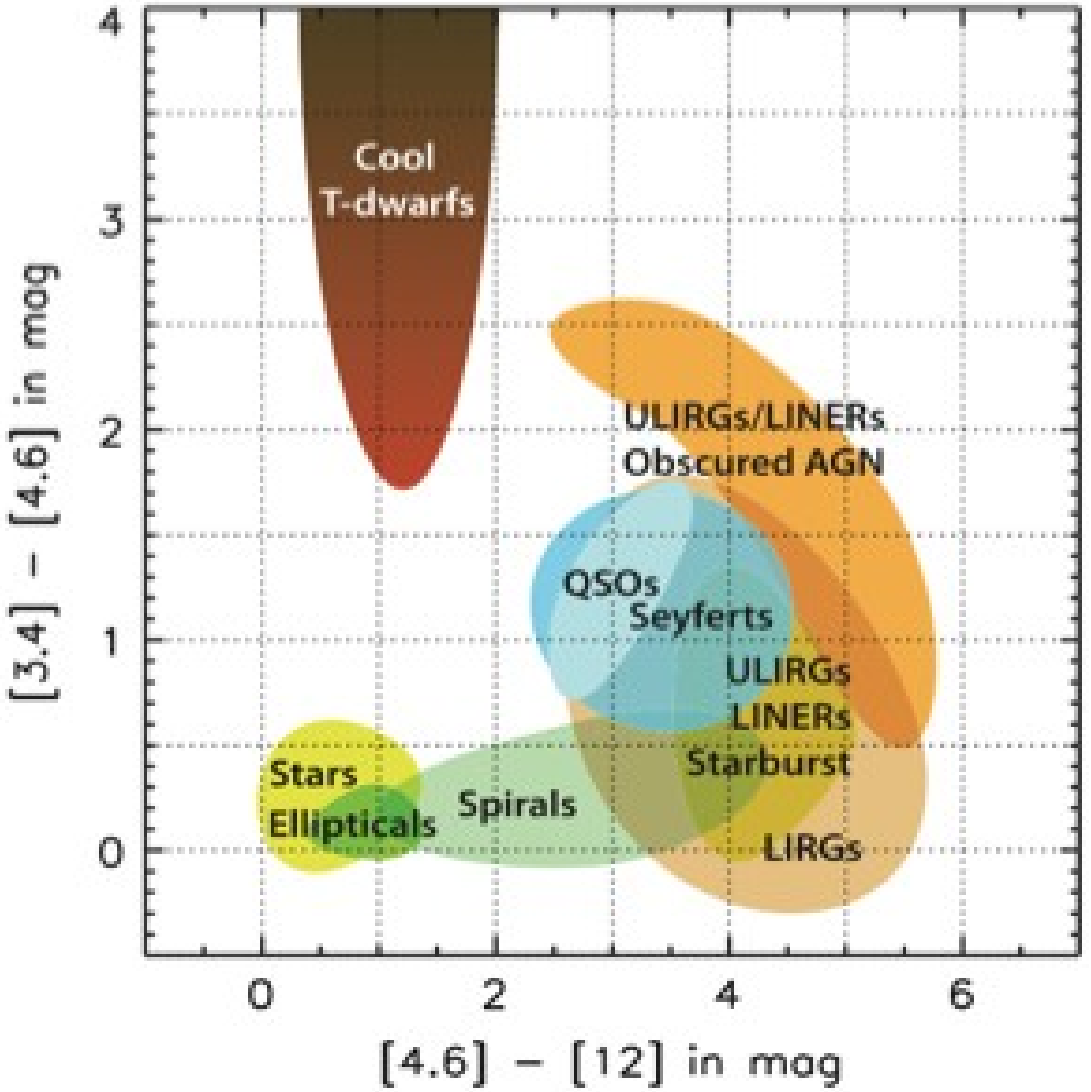
# Color selection (in optical)

- Quasars away from the stellar locus (mostly at z<2) are « easy » to find.
- Large spectroscopic surveys first focused on those « easy » quasars (e.g. Richards et al., 2005 or Croom et al., 2004)
- At higher redshift, quasars are closer to the stellar locus and are more difficult to find ! (e.g. Ross et al., 2012)

  → Loss of efficiency



# Color selection (in MIR)




WISE team

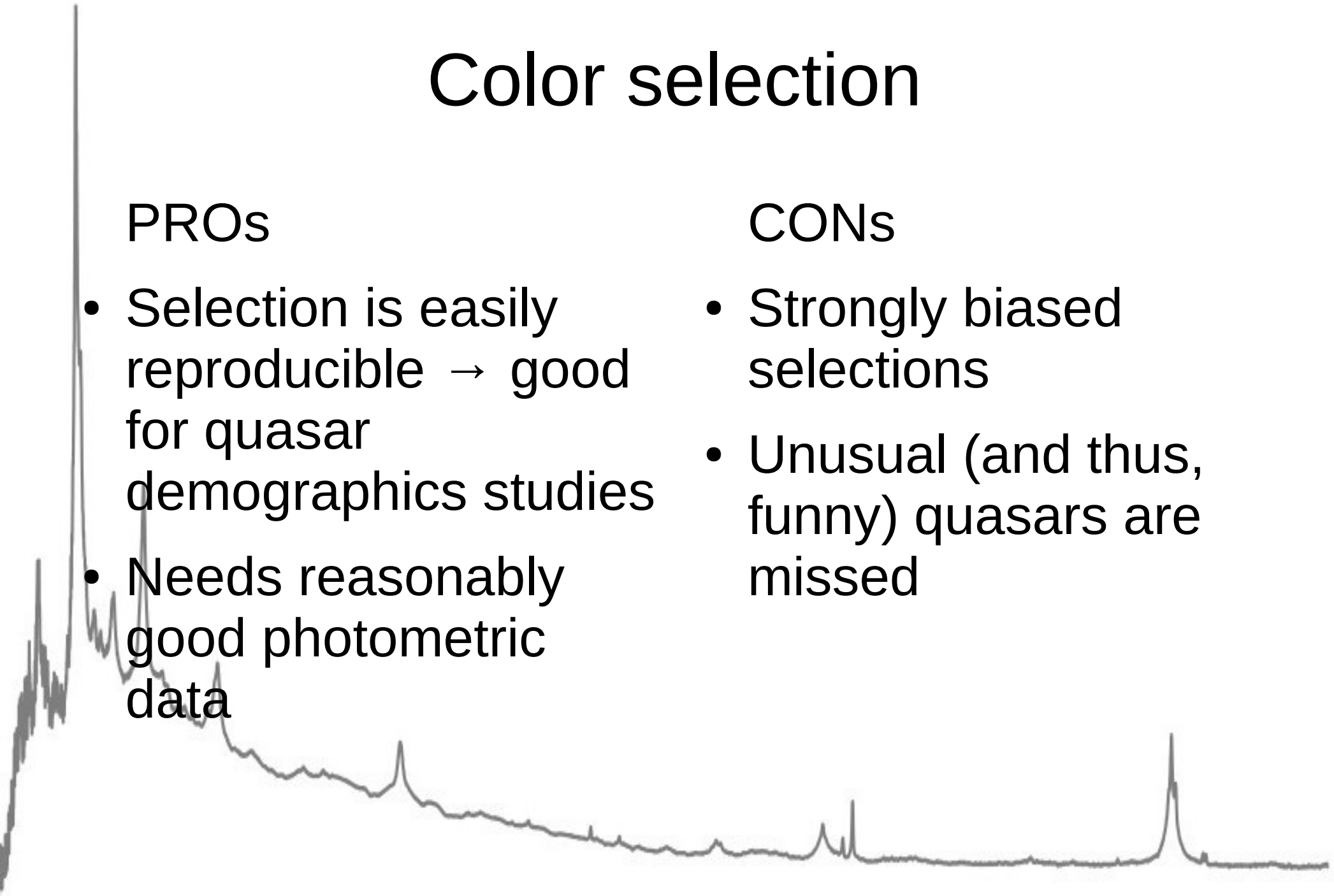
# Color selection

PROs

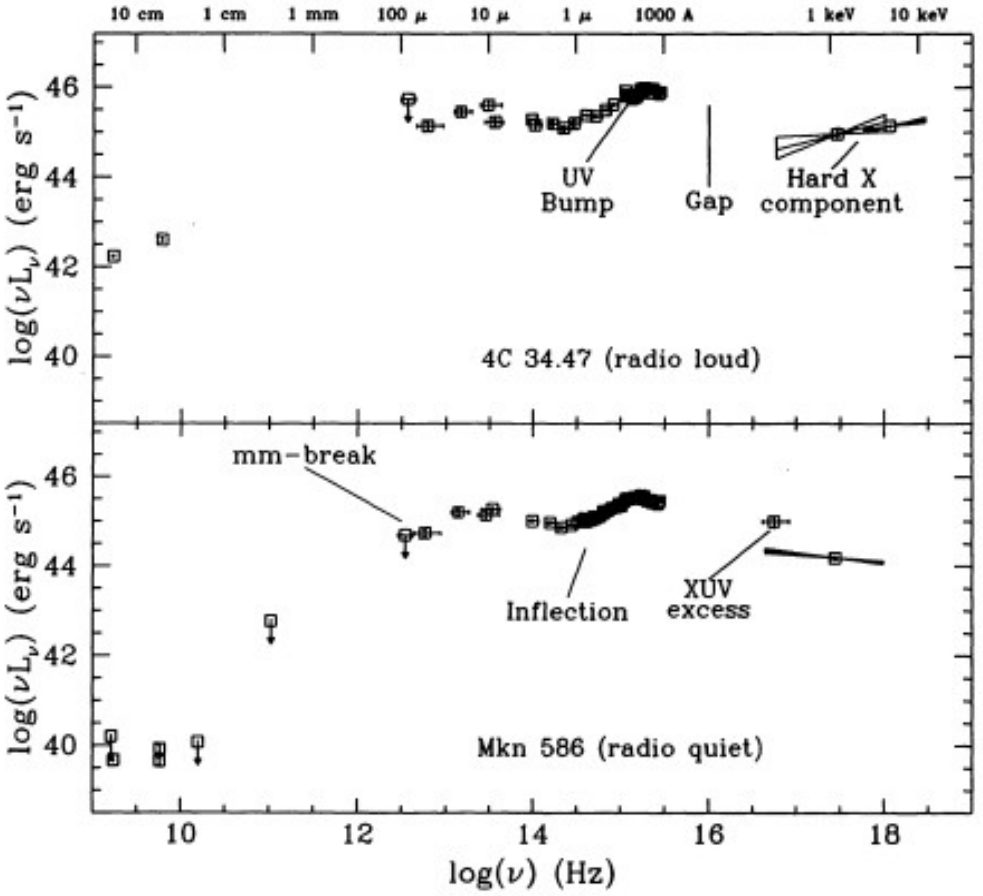
- Selection is easily reproducible → good for quasar demographics studies
- Needs reasonably good photometric data

CONs

- Strongly biased selections
- Unusual (and thus, funny) quasars are missed



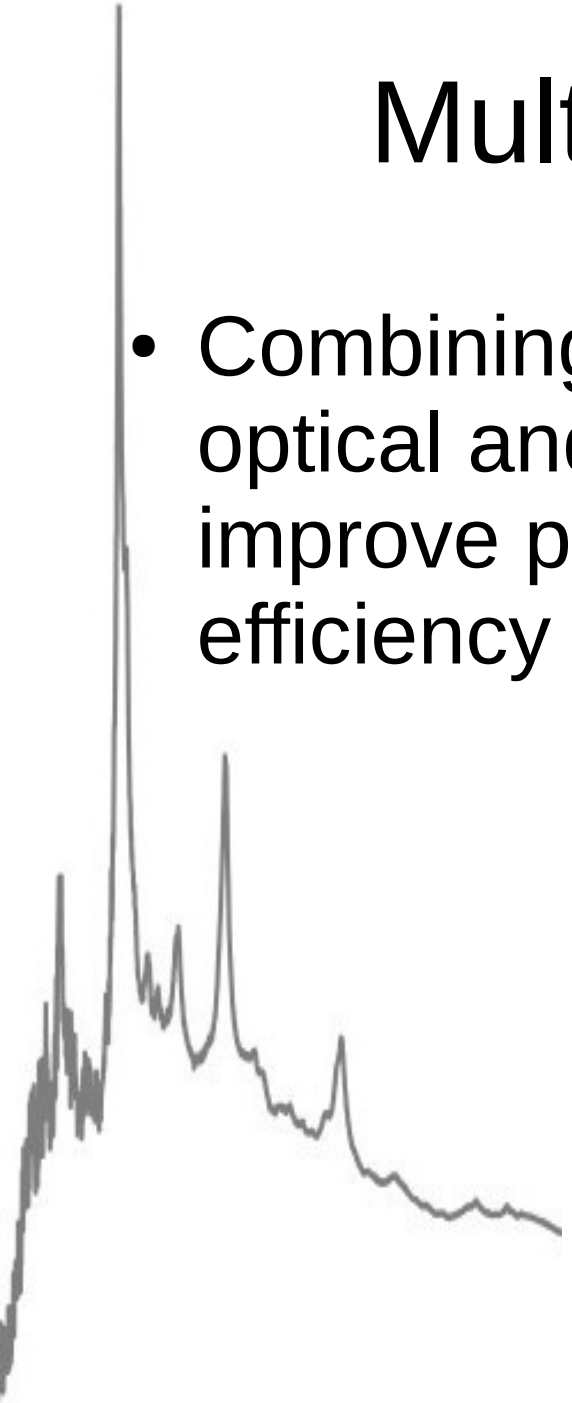
# Multi-wavelength selection

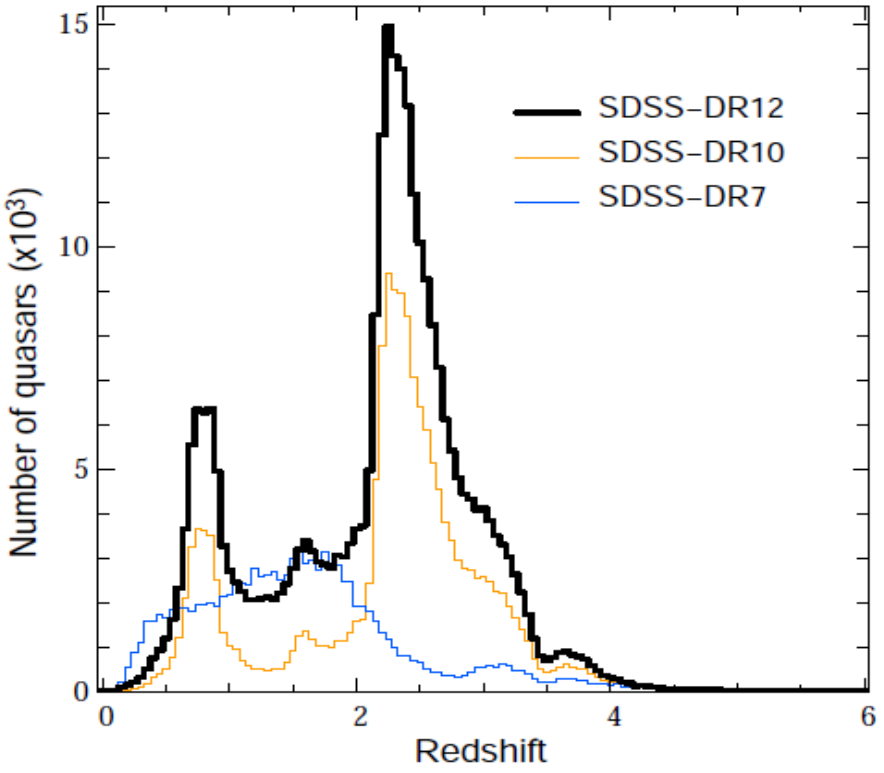


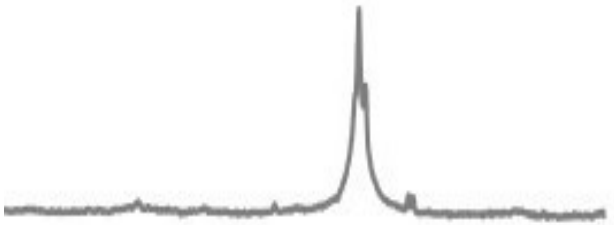

- Main contaminants are stars : use of multi-wavelength info to improve QTS
- Combined with color selection

# Multi-wavelength selection

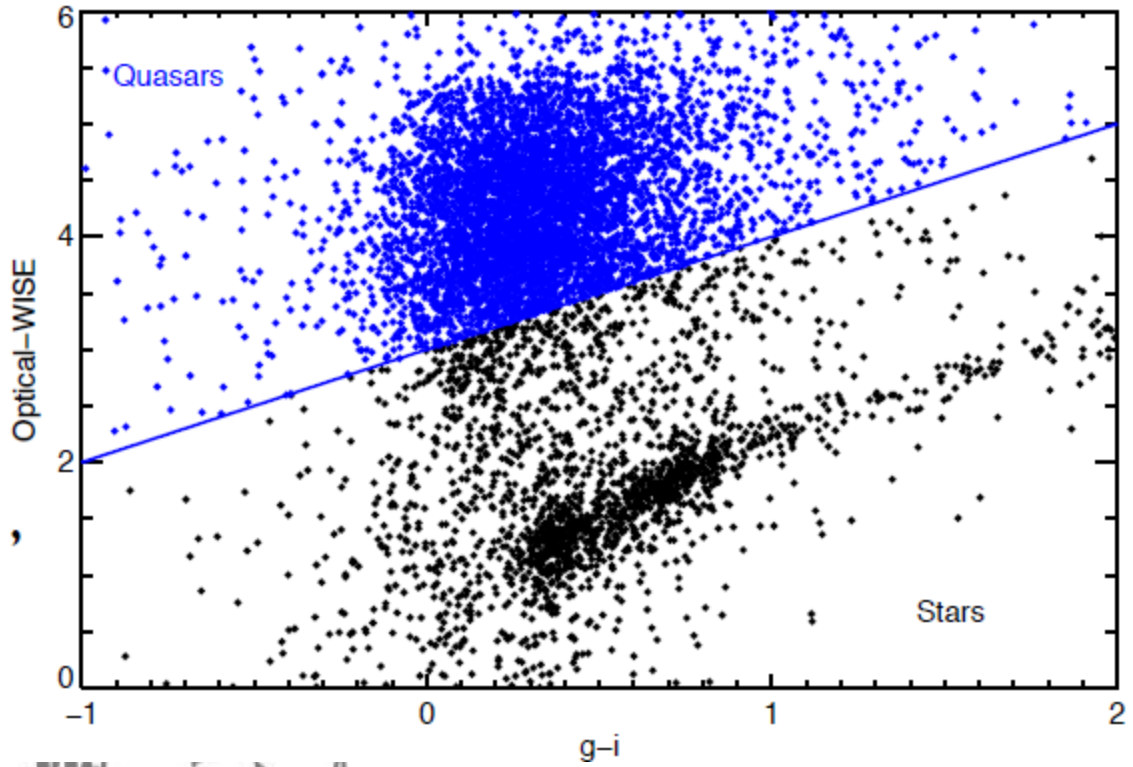
- Combining standard color selection in the optical and add info from other wavelengths to improve photometric redshift accuracy and efficiency (e.g. Bovy et al., 2011)





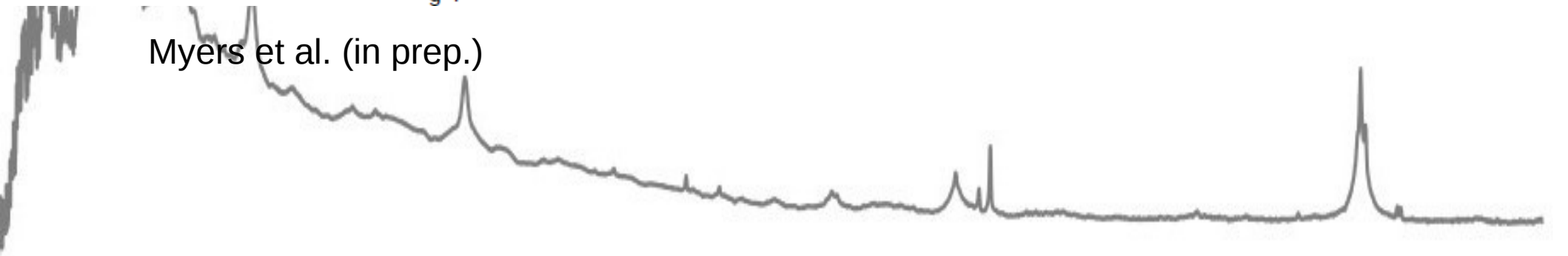



# Multi-wavelength selection



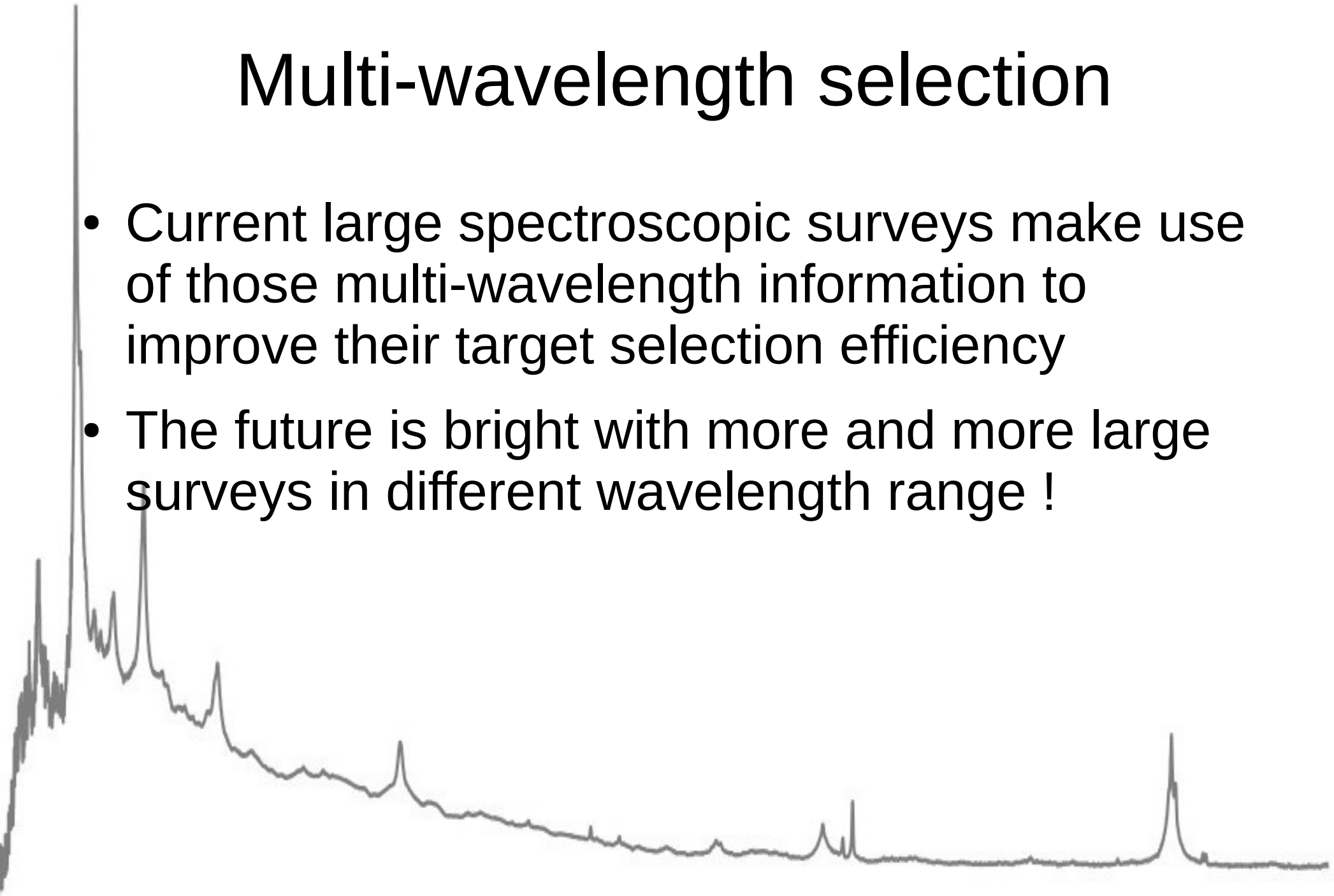

- Reject stars by combining optical and IR data (e.g. WISE)

Myers et al. (in prep.)



# Multi-wavelength selection

- Current large spectroscopic surveys make use of those multi-wavelength information to improve their target selection efficiency
- The future is bright with more and more large surveys in different wavelength range !

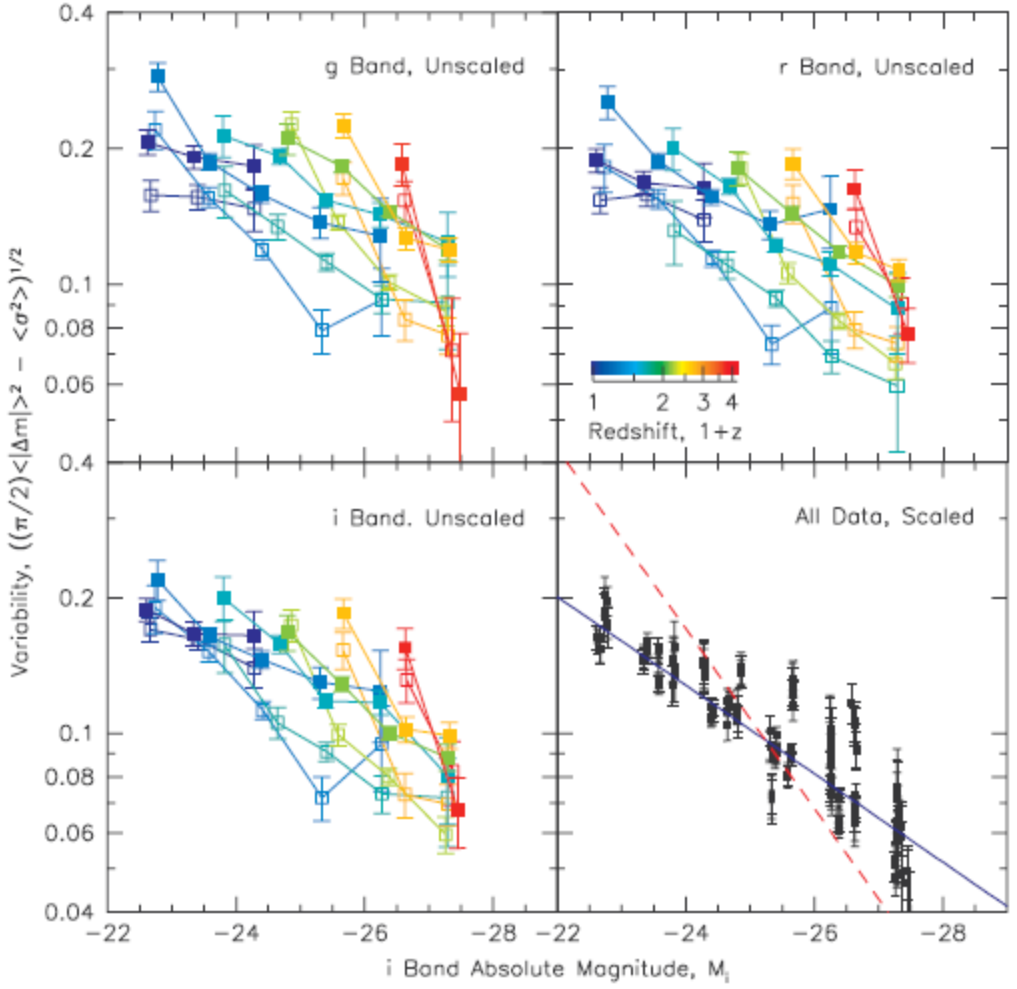


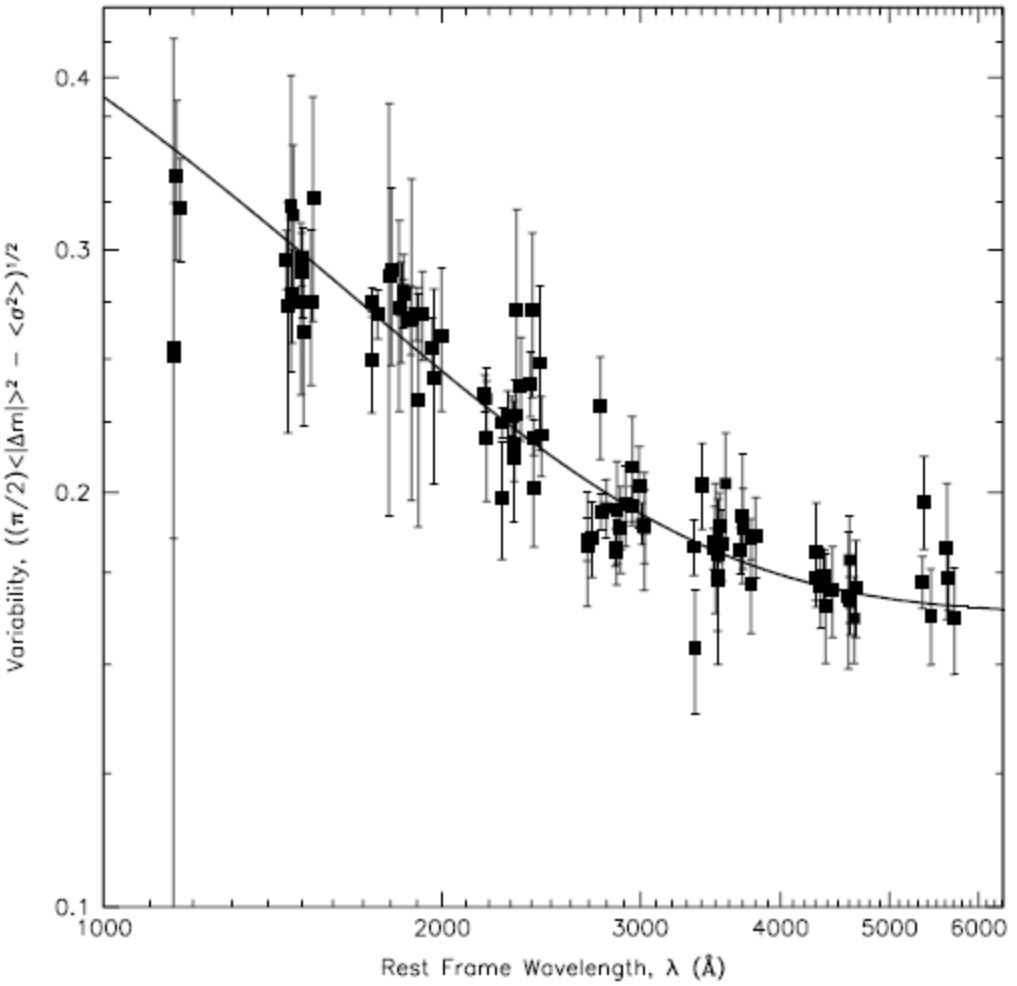
# Variability selection

Urry & Padovani (1995)

- Quasars are variable objects !!!
- Probably due to accretion disk instabilities (e.g. Vanden Berk et al., 2004)

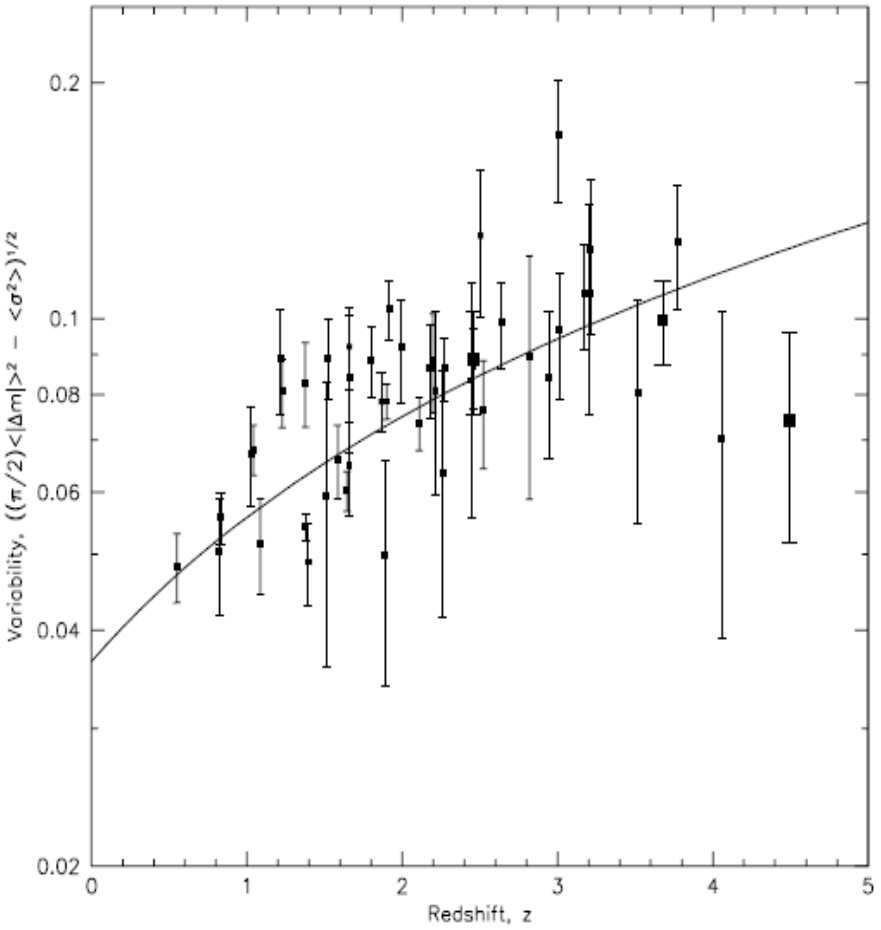
# Variability selection




Vanden Berk et al. (2004)

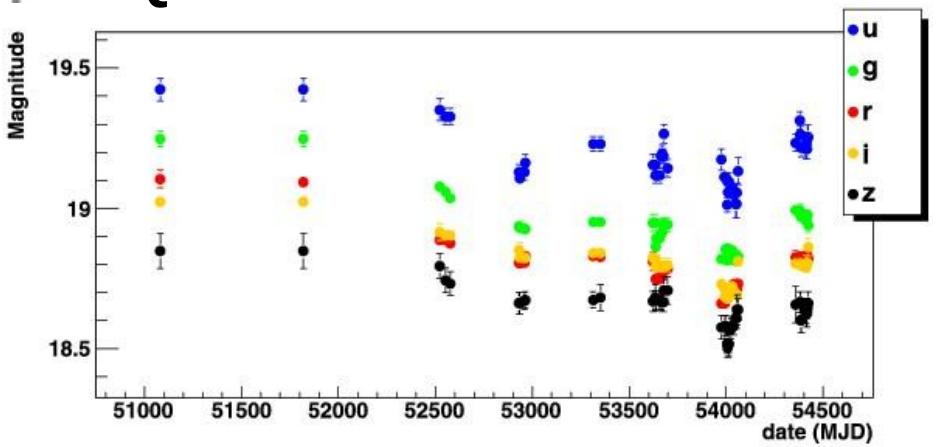
# Variability selection

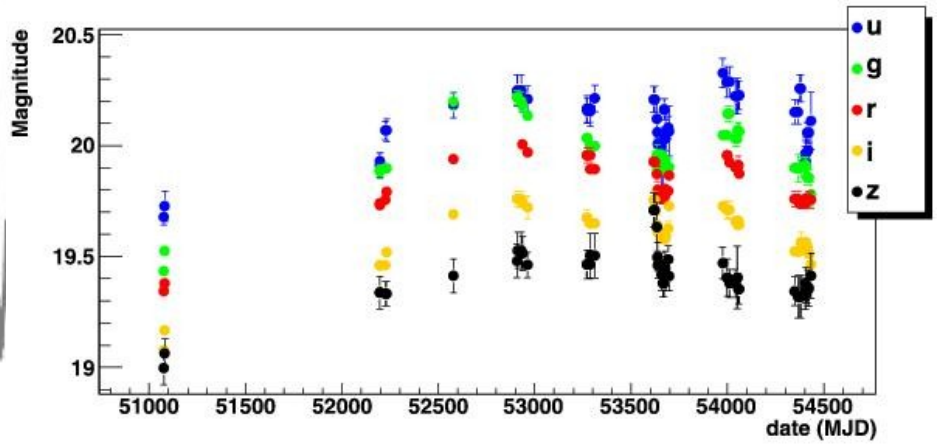



Vanden Berk et al. (2004)

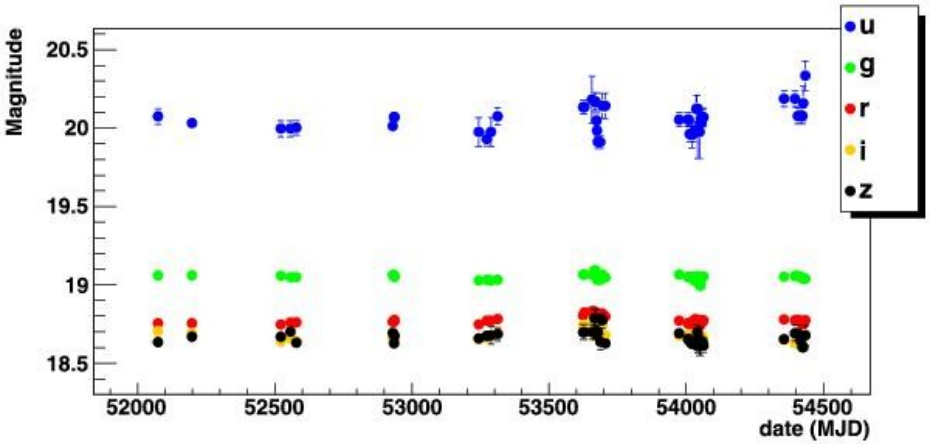
# Variability selection (in optical)

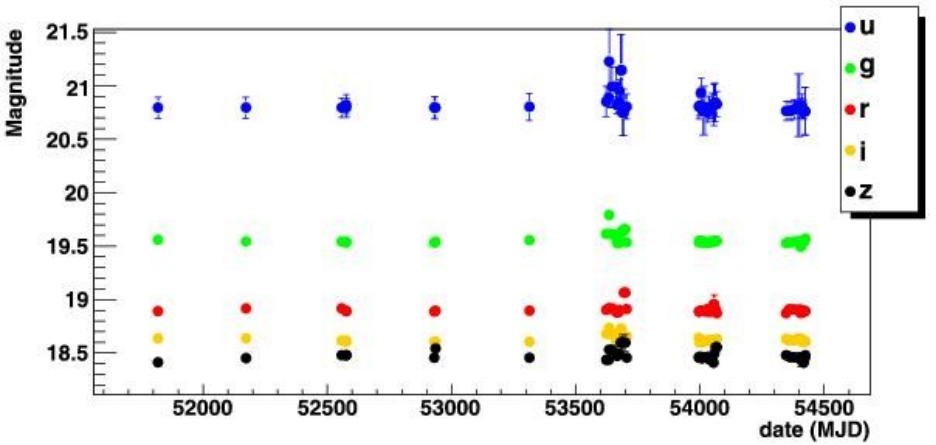
**QUASAR**




**STAR**

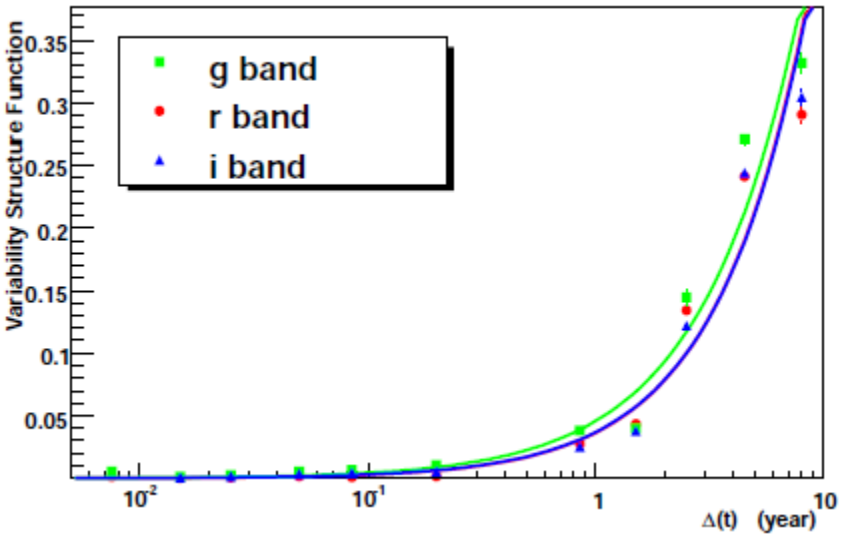


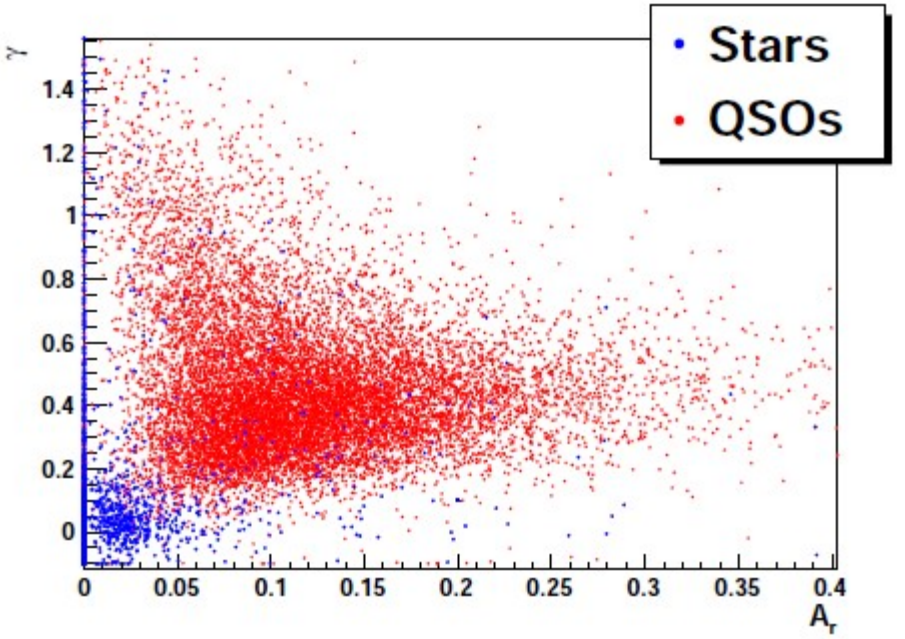




Palanque-Delabrouille et al. (2011)

# Variability selection (in optical)

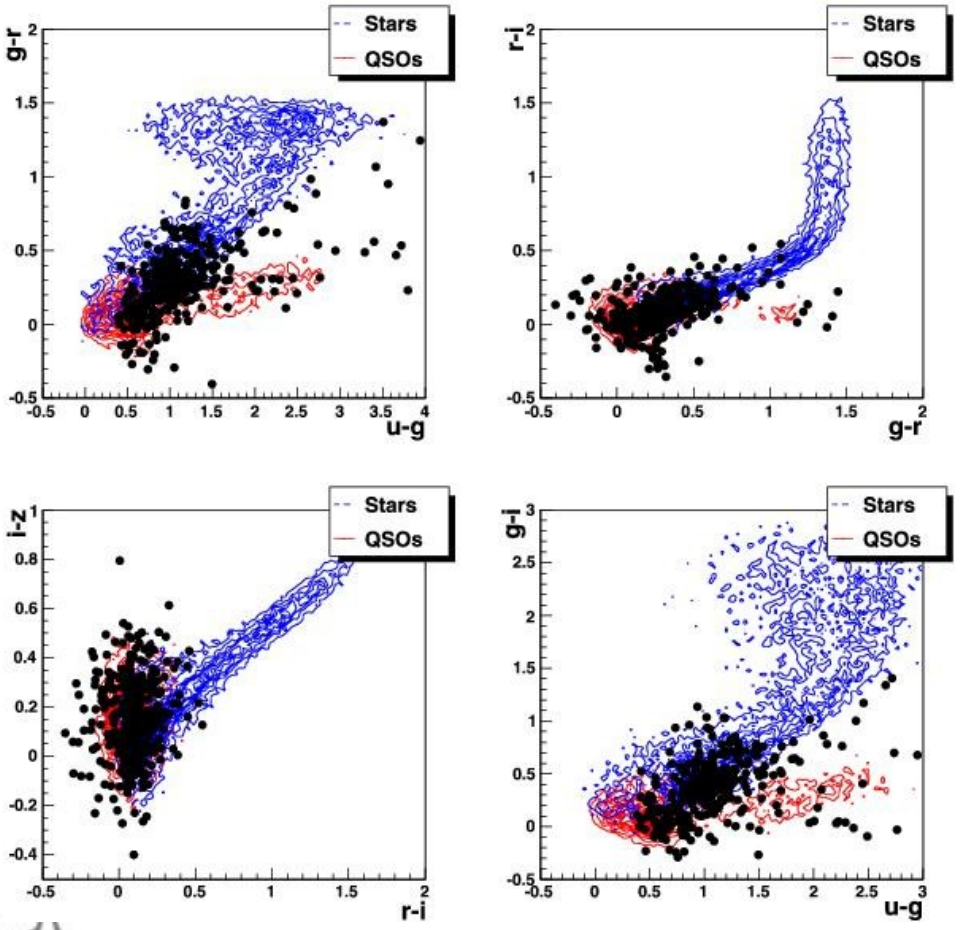
- We separate quasars from stars efficiently




Palanque-Delabrouille et al. (2011)

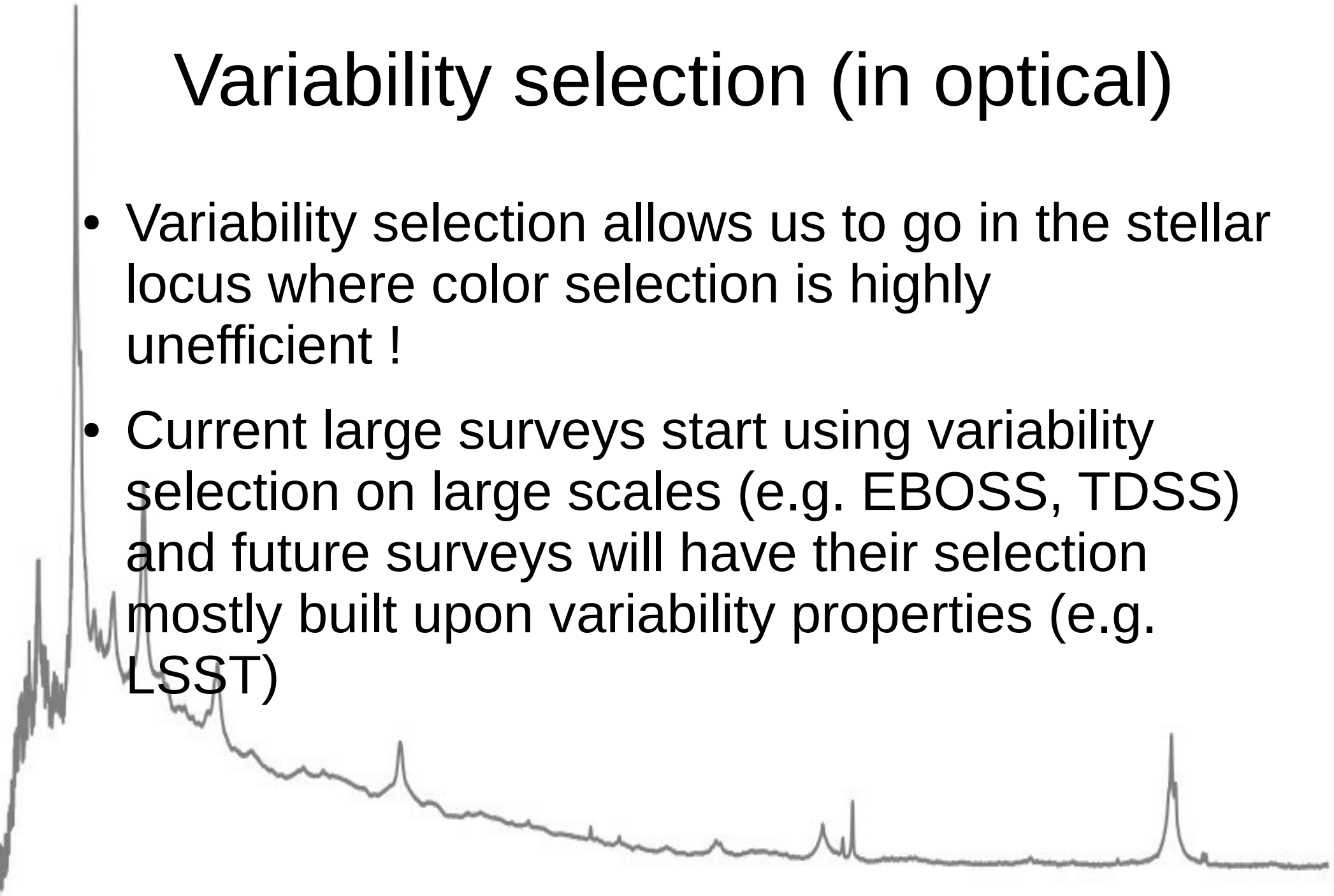
# Variability selection (in optical)




Palanque-Delabrouille et al. (2011)

# Variability selection (in optical)

- Variability selection allows us to go in the stellar locus where color selection is highly unefficient !
- Current large surveys start using variability selection on large scales (e.g. EBOSS, TDSS) and future surveys will have their selection mostly built upon variability properties (e.g. LSST)



# Future selection

How can we have the ultimate quasar target selection ?

→ Combine data in all wavelength ranges, take into account their variability properties and astrometric properties !