QSO SEDs as seen by WISE-UKIDSS-SDSS

Isaac Roseboom, IfA Edinburgh
w/ A. Lawrence, M. Elvis, S. Petty, Yue Shen, H. Hao

Mon. Not. R. Astron. Soc. **000**, 1–8 (2012) Printed 22 May 2012 (MN LATEX style file v2.2)

IR-derived covering factors for a large sample of quasars from WISE-UKIDSS-SDSS

I.G. Roseboom,[1*], A. Lawrence[1], M. Elvis[2], S. Petty[3], Yue Shen[2], H. Hao[2,4]

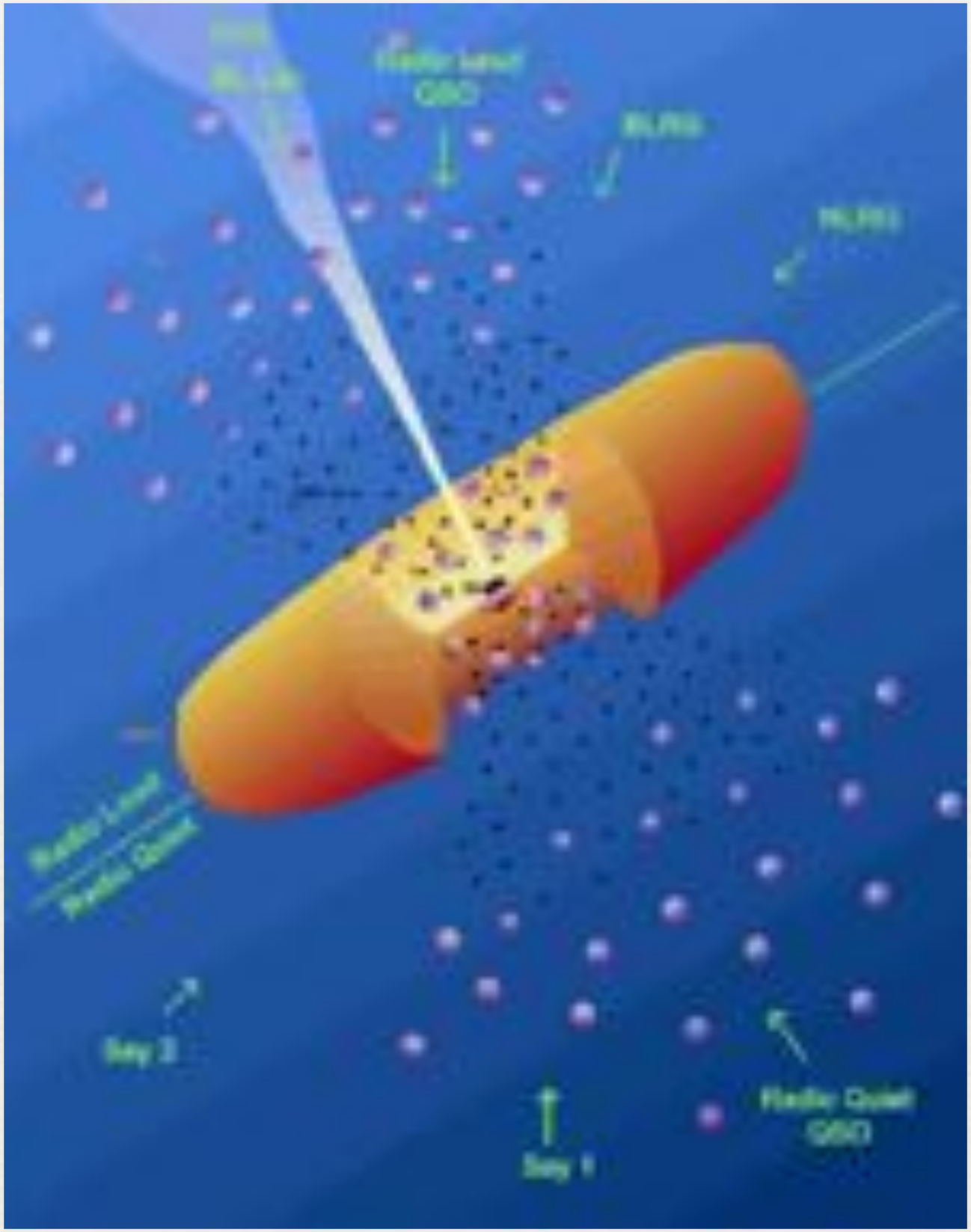
[1] *Institute for Astronomy, University of Edinburgh, Royal Observatory, Blackford Hill, Edinburgh EH9 3HJ, UK*
[2] *Harvard-Smithsonian Center for Astrophysics, 60 Garden St. Cambridge MA02138 USA*
[3] *Physics and Astronomy Department, University of California, Los Angeles, CA 90095-1547, USA*
[4] *SISSA, Via Bonomea 265, I-34136 Trieste, Italy*

22 May 2012

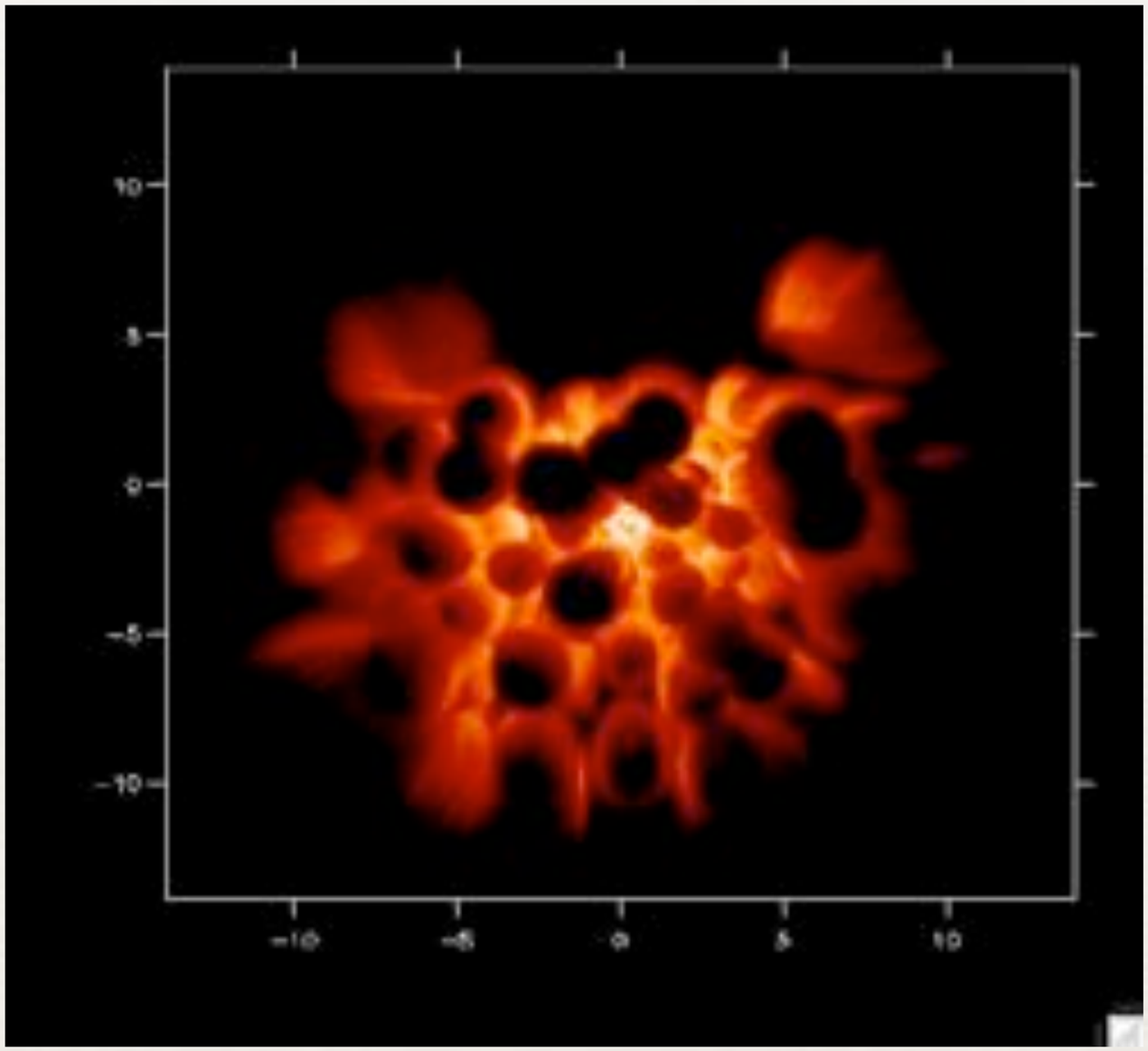
ABSTRACT

We investigate the range of covering factors (determined from the ratio of IR to UV/optical luminosity) seen in luminous quasars using a combination of data from the WISE, UKIDSS and SDSS surveys. Accretion disk (UV/optical) and obscuring dust (IR) luminosities are measured via the use of a simple three component SED model. We use these estimates to investigate the distribution of covering factors and its relationship to both accretion luminosity and IR SED shape. The distribution of covering factors (f_C) is observed to be log-normal, with a bias-corrected mean of $< \log_{10} f_C >= -0.48$ and standard deviation of $\sigma = 0.19$. The fraction of IR luminosity emitted in the near-IR (1–5 μm) is found to be high (~ 40 per cent), and dependant on covering factor.

Key words: quasars: general, infrared: general



Urry & Padovani (PASP, 1995)



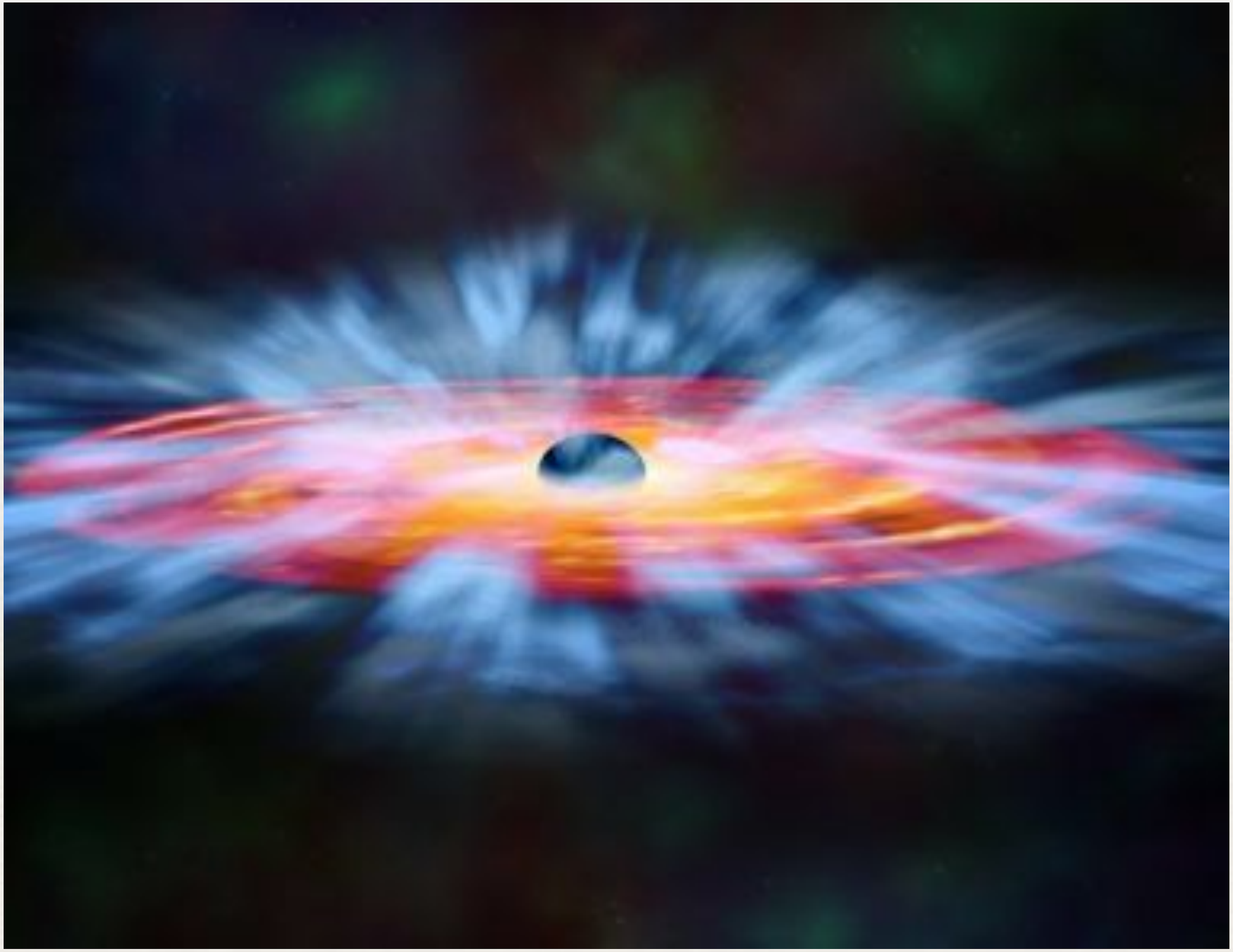
Clumpy torus

Dullemond et al.

Current paradigm for AGN models(? c.f. smooth models Vignali et al. 2011)

Much effort applied to predict observables (IR SED) - e.g. Nenkova et al. 2008; Honig et al. 2010; Stalevski et al. 2012

No physical meaning - May well fit data but where did this material come from?



Accretion disk winds? (e.g. Elitzur 2002)

Artwork Credit: NASA, and M. Weiss (Chandra X -ray Center)

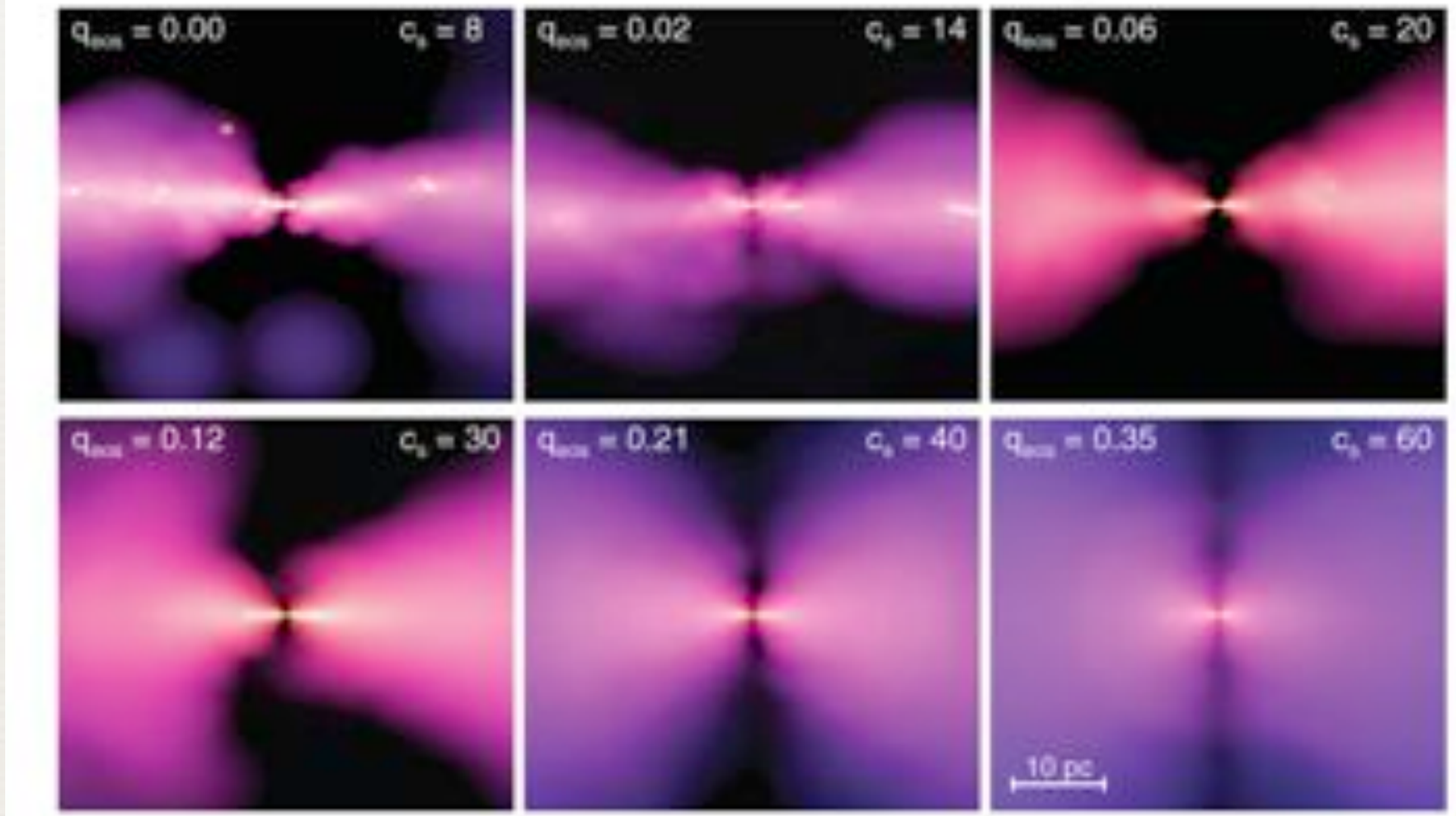
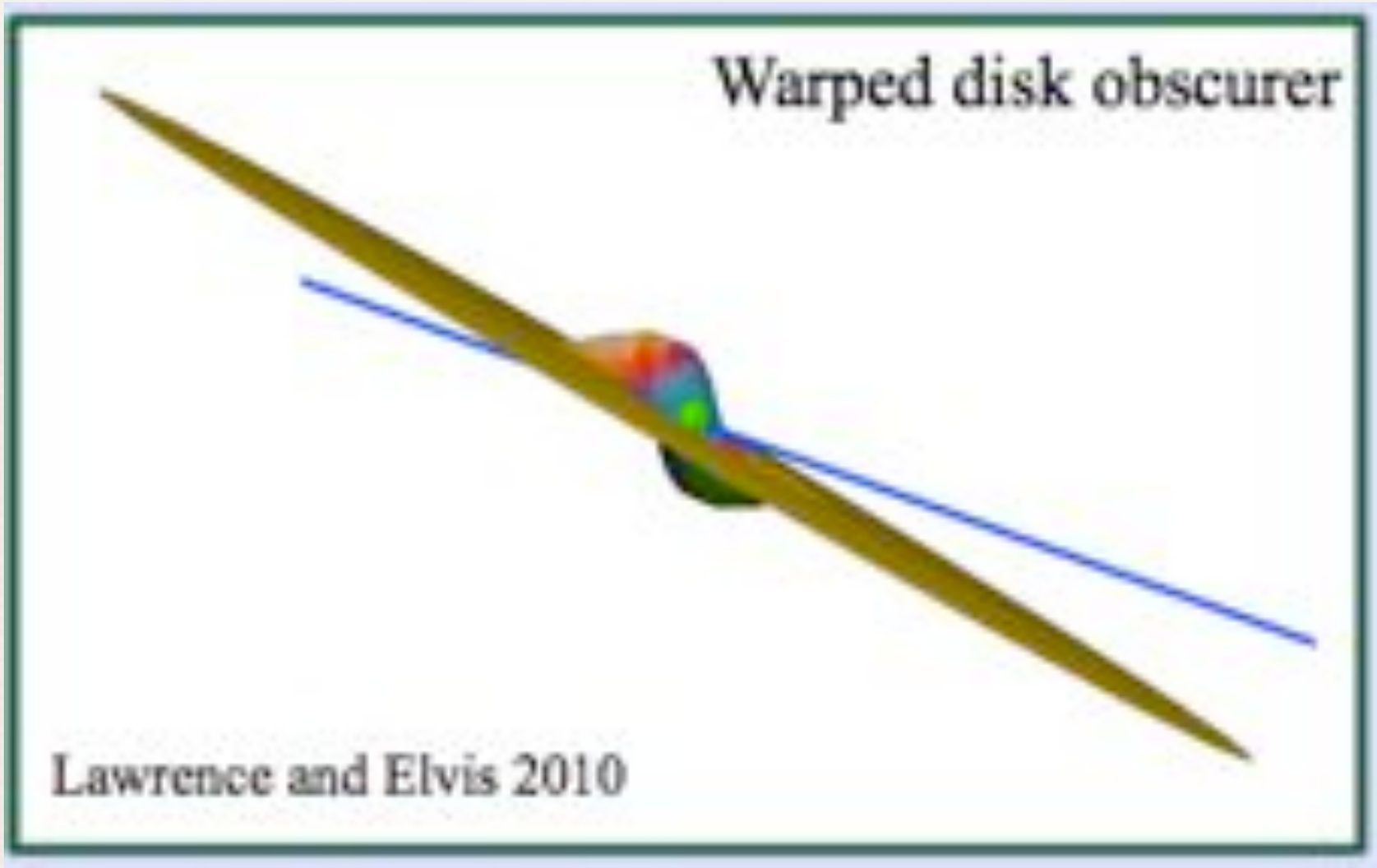


Figure 2. Edge-on gas mass distribution plotted in cylindrical coordinates (R, z) to highlight the torus-like structure of the disc, with intensity and colour as Fig. 1. The simulations shown here are a survey of q_{acc}, which determines the effective (subgrid) pressure support of the ISM: the (mass-averaged) effective subgrid sound speed c_s is labelled in each panel. Fig. 1 for some of our survey of q_{acc}. As expected, the systems become more puffed-up with increasing q_{acc} (subgrid c_s), and for $q_{acc} \gtrsim 0.4$ they are nearly spherical. But at small q_{acc}, the scale heights do not decrease as rapidly as $\propto c_s$, but approach some asymptotic minimum.

Infalling star forming gas? (e.g. Cattaneo et al. 2005)

Hopkins et al. 2012

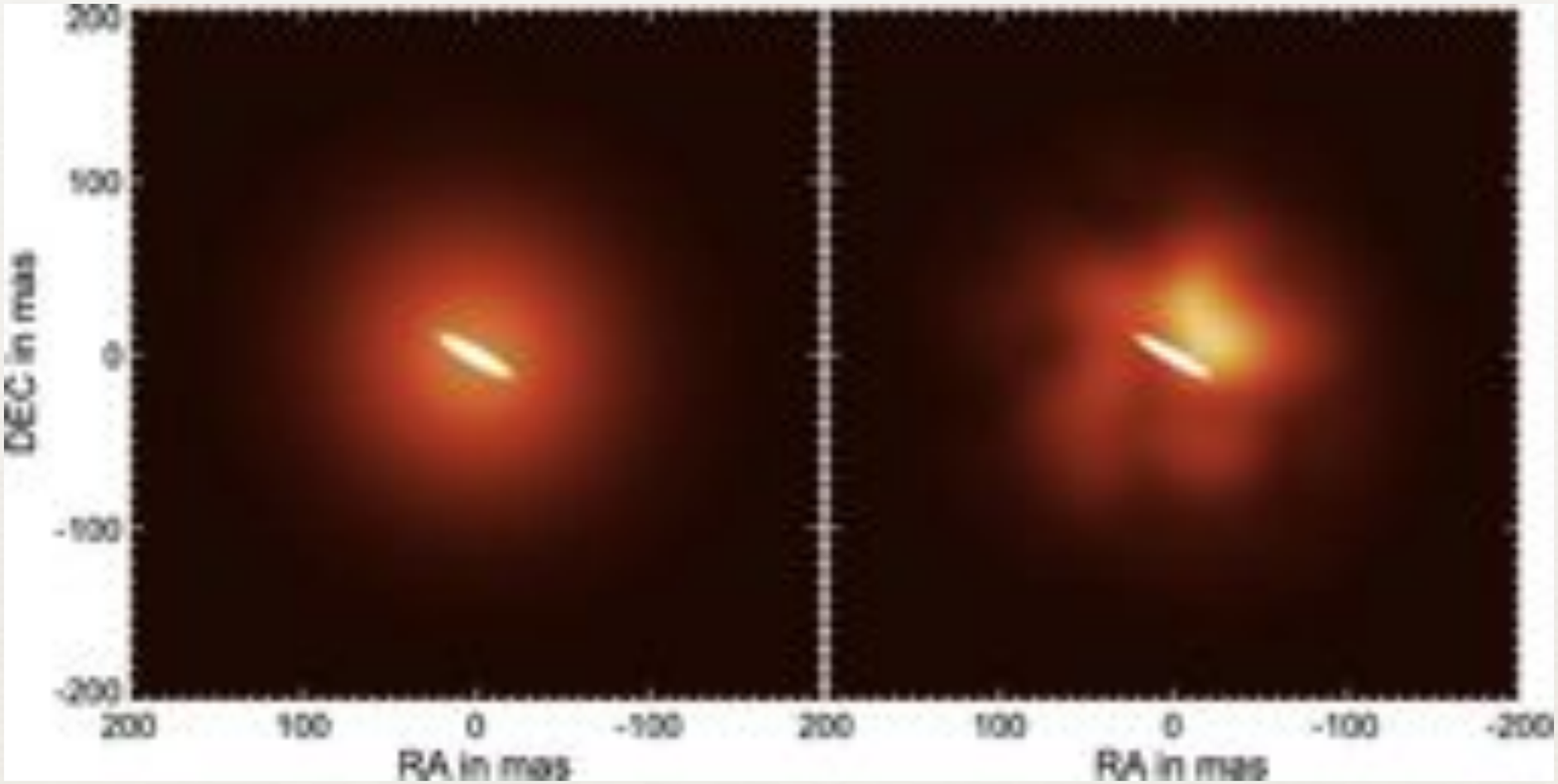


Leading to warped accretion disks?

Testing Unified Models

- Need some way to discriminate between these physical models
- Some make predictions of observables (e.g. warped disks), most not
- Progress requires both advance in modelling and observational constraints

Direct observations may never be possible for large samples!

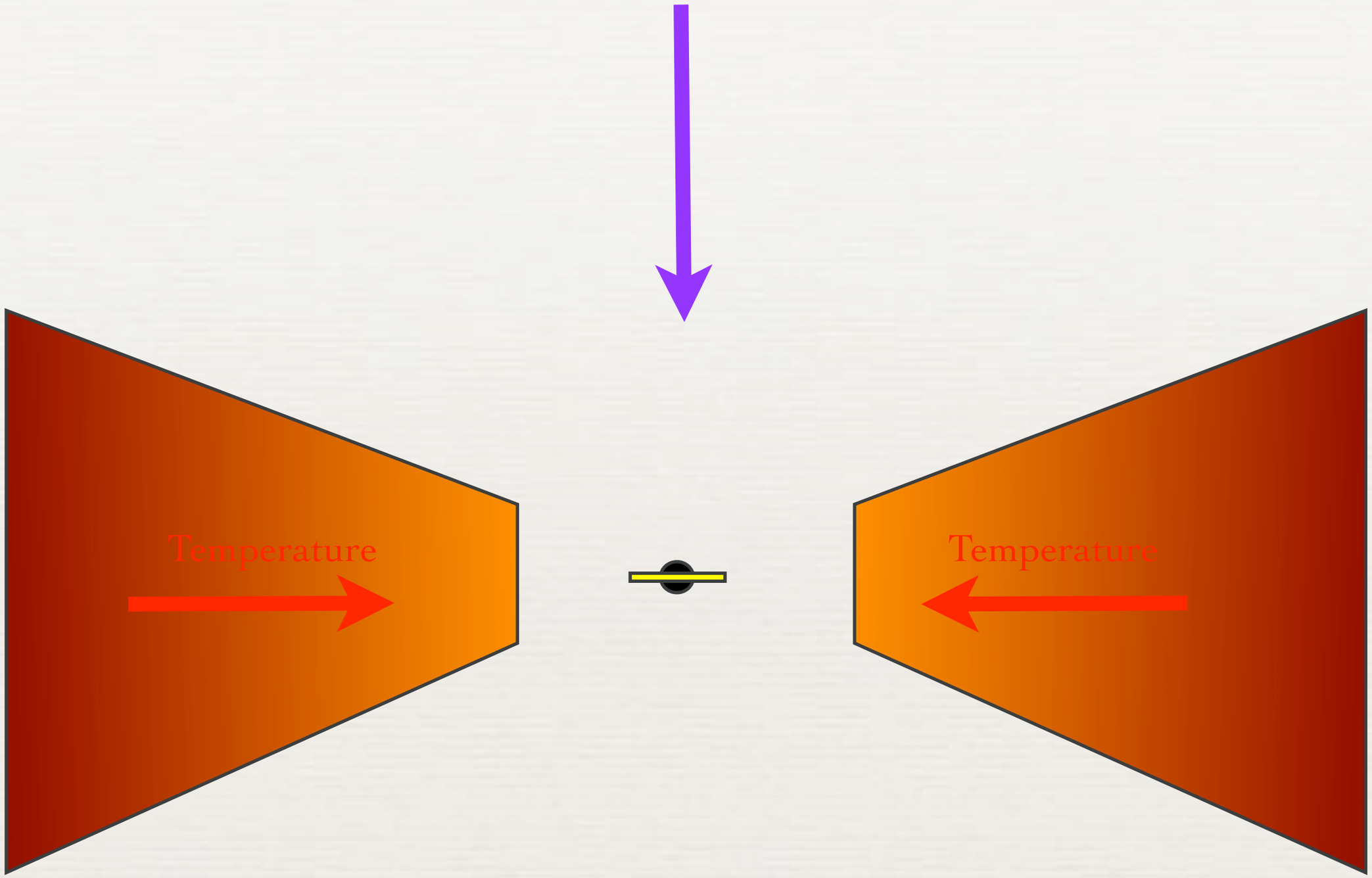


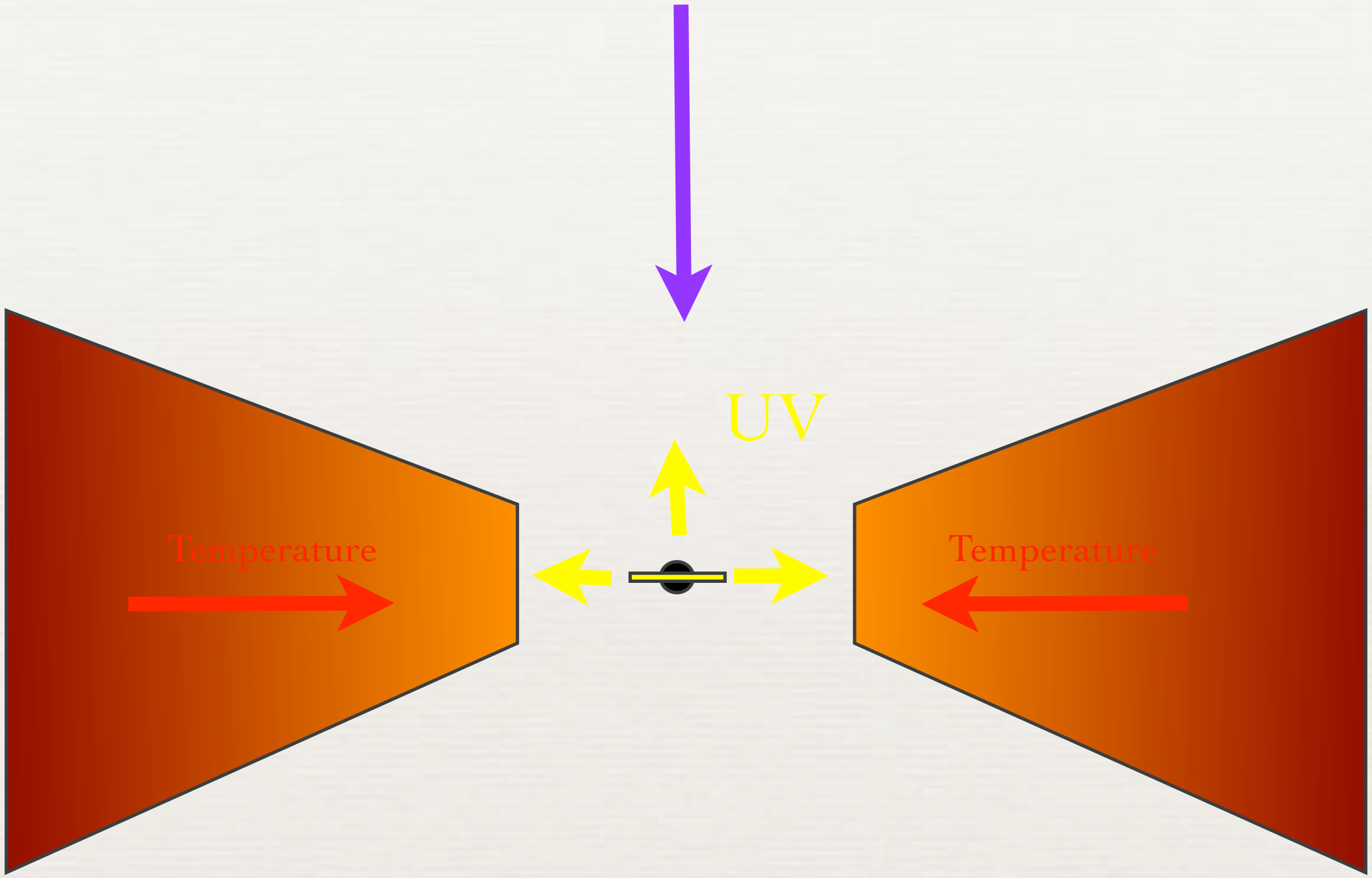
Circinus @ *4*Mpc with VLT MIDI

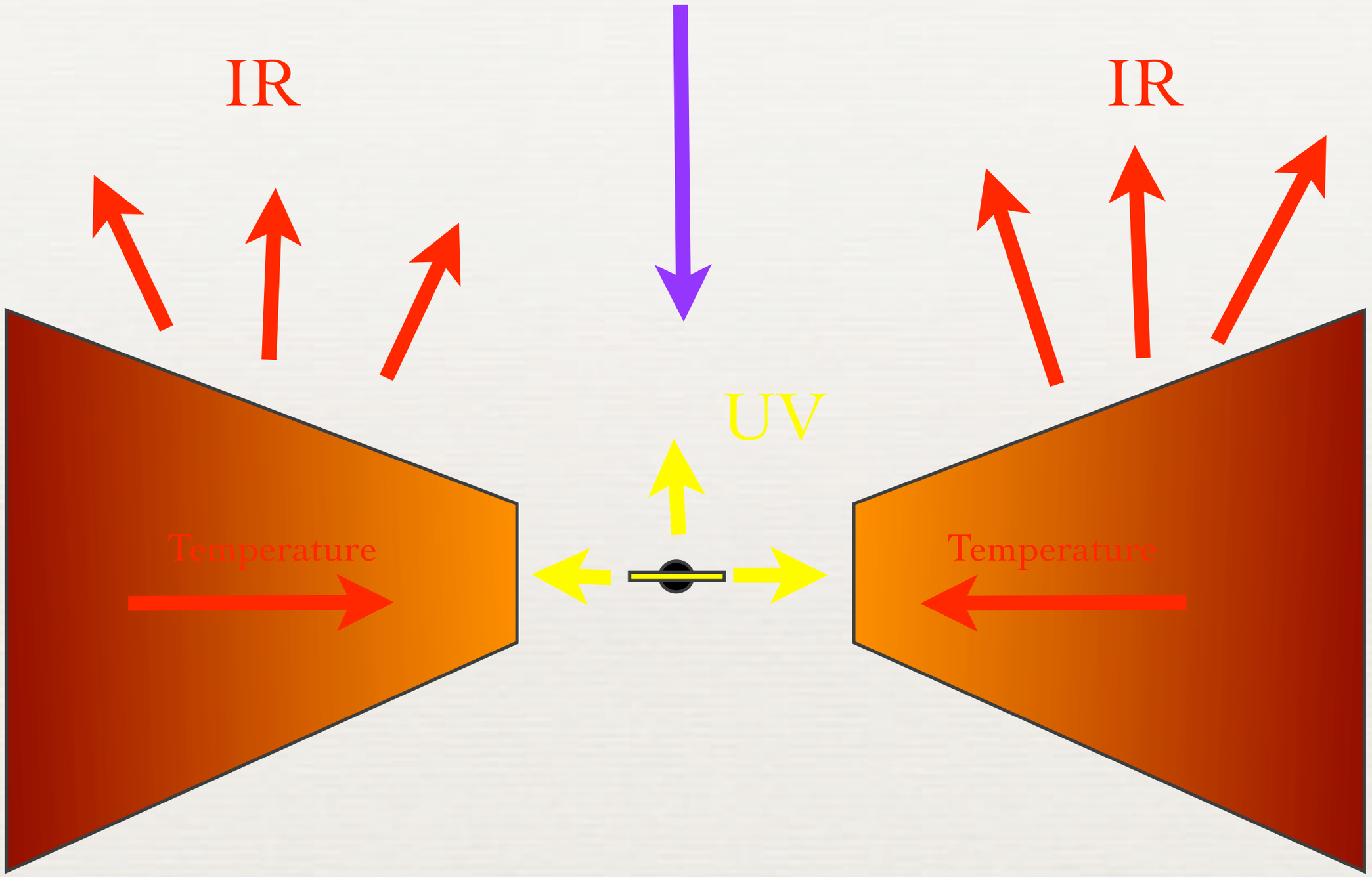
Tristam et al 2007

Obscuring material in AGN

- Need indirect information about “torus” properties -> statistical samples
- For Type 1 QSOs - use relationship between UV/optical (accretion disk) and Mid-IR (dusty material) luminosity to give “covering factor”

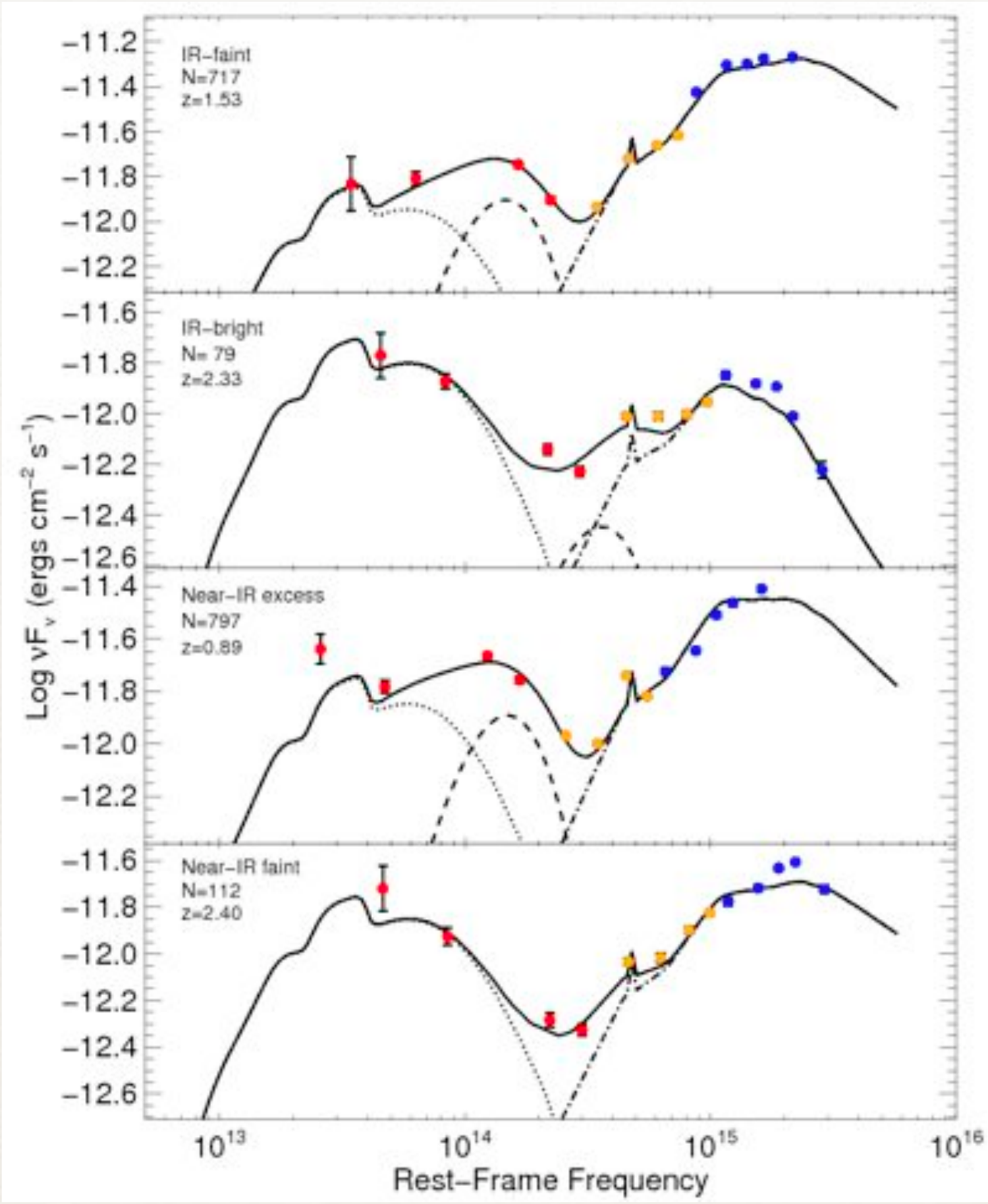

Temperature
Temperature


UV
Temperature
Temperature


IR
IR
UV
Temperature
Temperature

WISE-UKIDSS-SDSS QSOs

- Use a combination of WISE all-sky and UKIDSS LAS data to constrain IR SEDs of QSOs
- Parent sample: 69k SDSS DR7 QSOs (with Lbol>10^46)
- ~25k have UKIDSS LAS overlap
- ~10k have WISE detections at 4 IR-bands

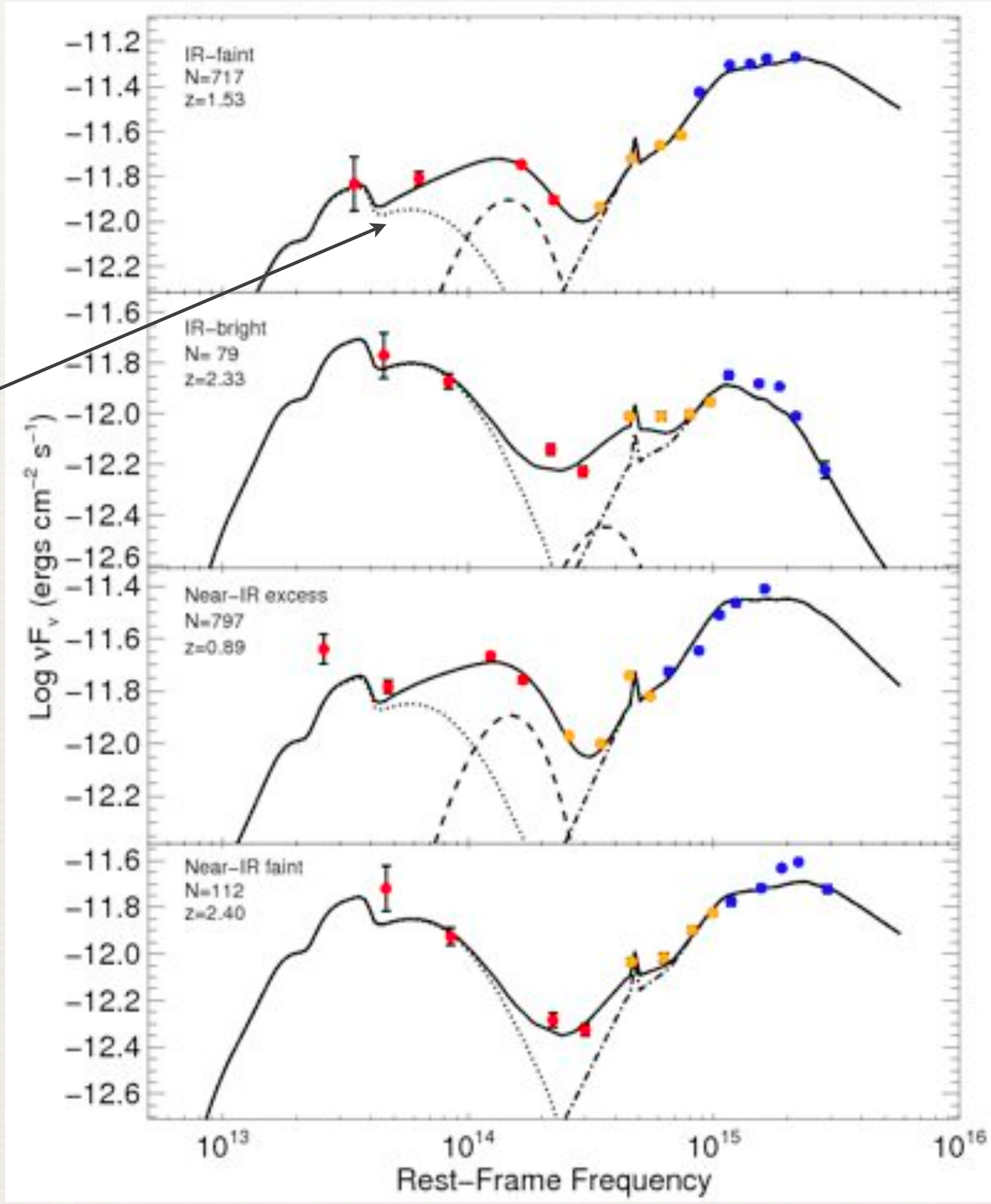


SDSS

UKIDSS

WISE

Clumpy torus model (Nenkova 2008)



SDSS

UKIDSS

WISE

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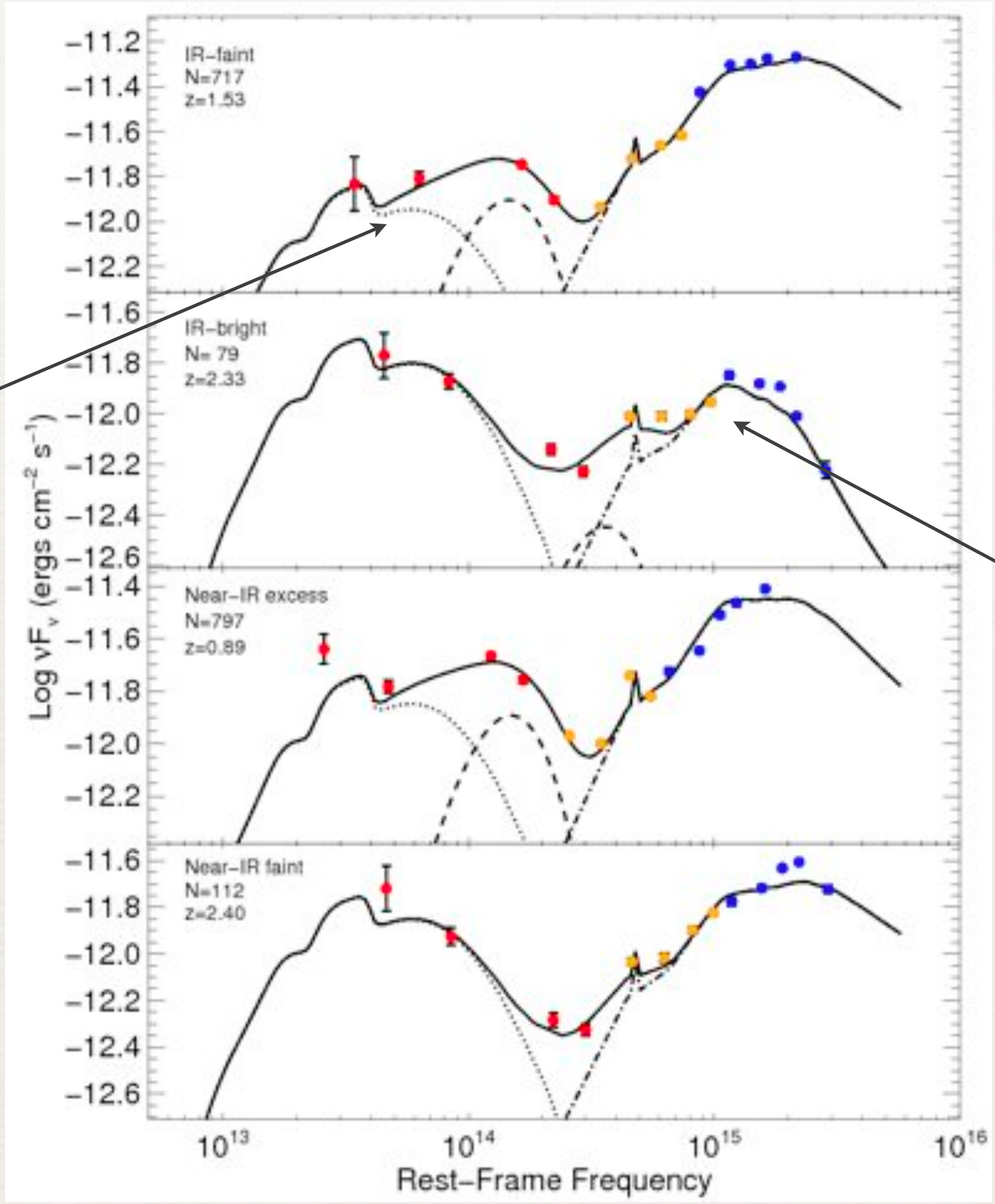


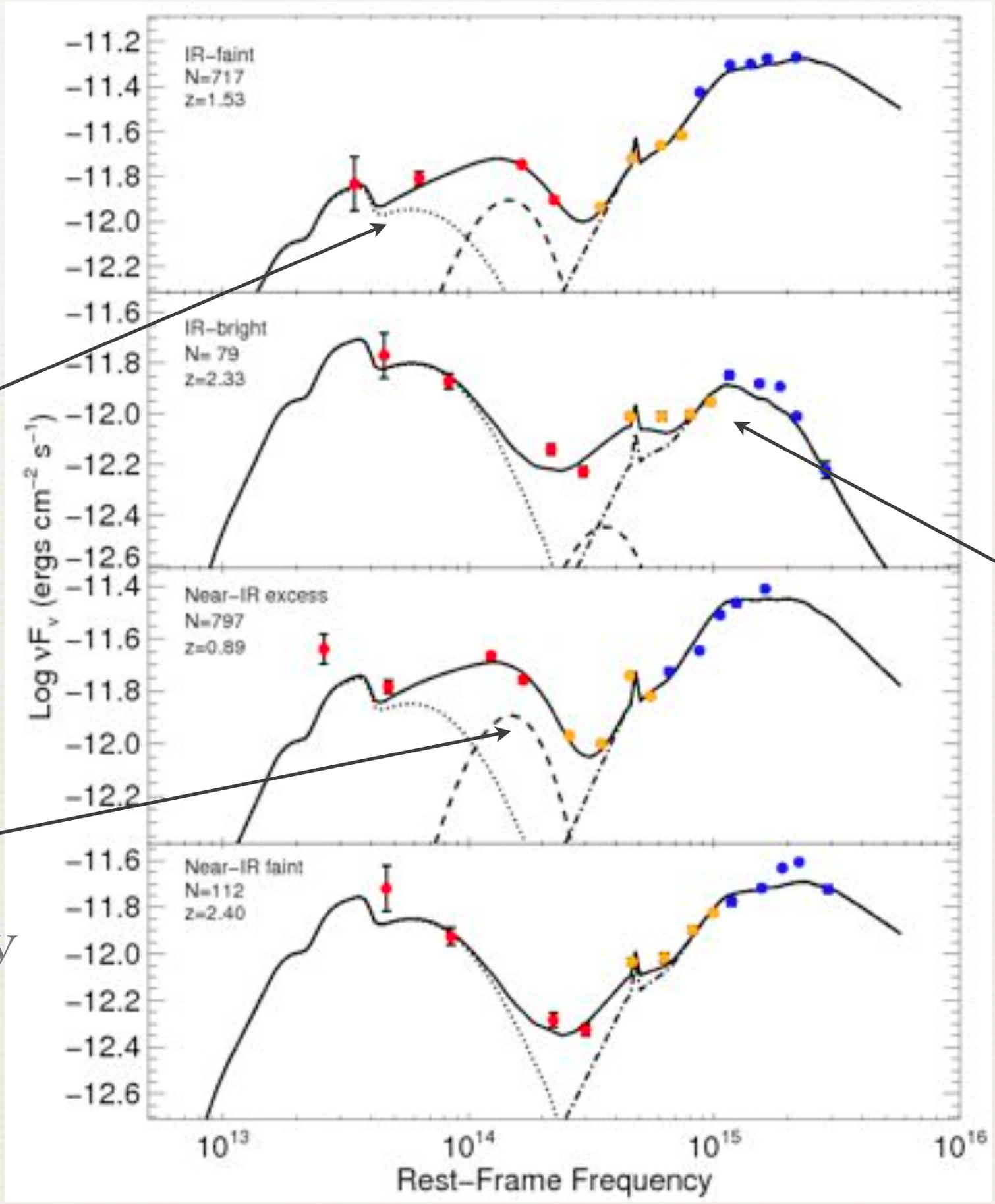
SDSS

UKIDSS

WISE

Elvis 1994 QSO mean SED

Clumpy torus model (Nenkova 2008)



SDSS

UKIDSS

WISE

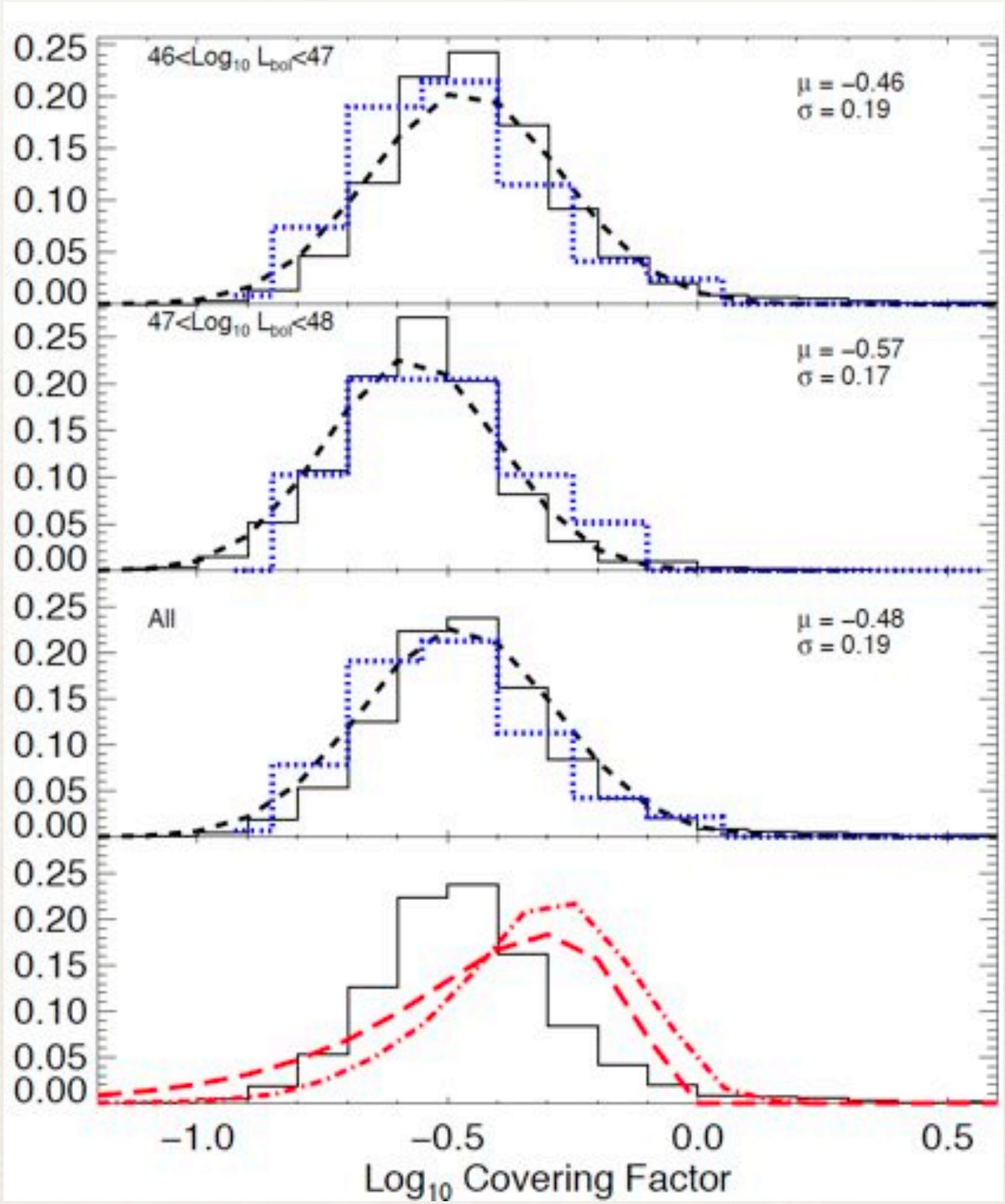
Elvis 1994 QSO mean SED

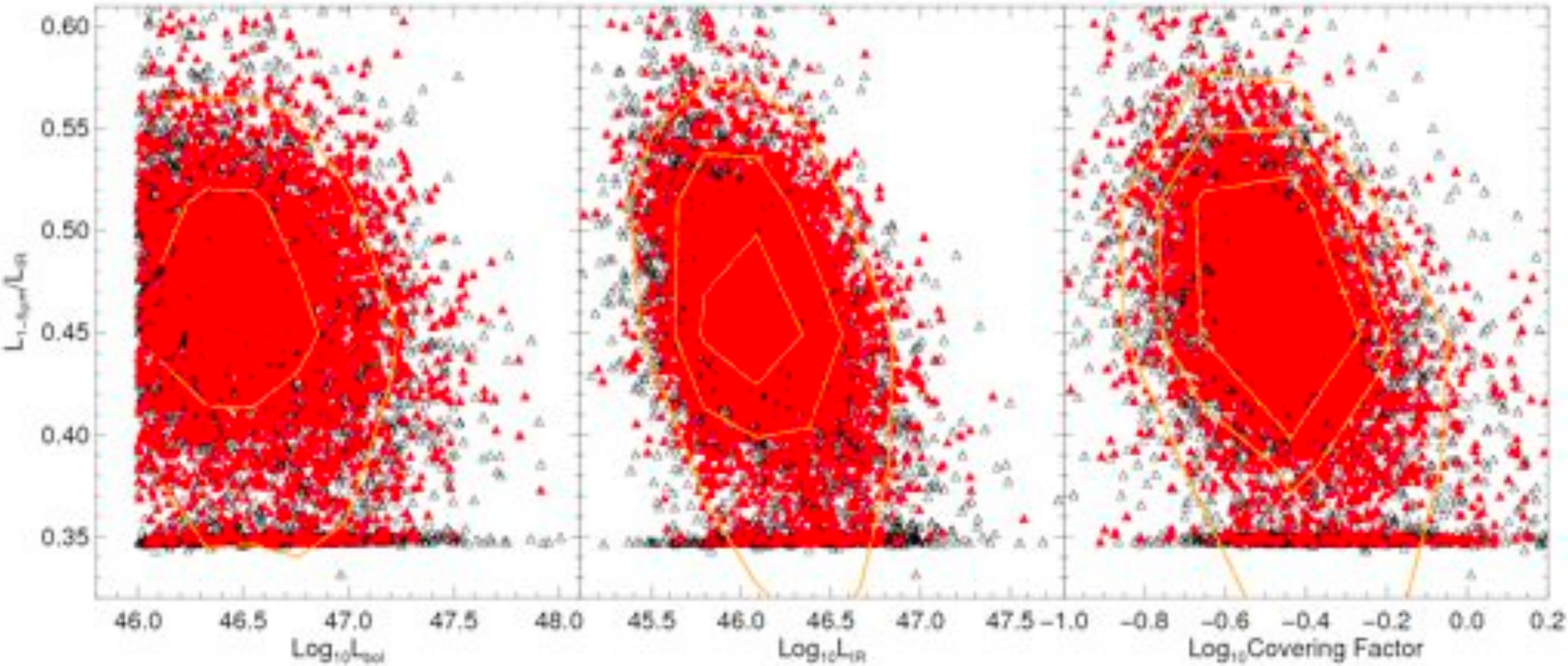
Modified black body

Use IR/UV ratio to determine "covering factor"

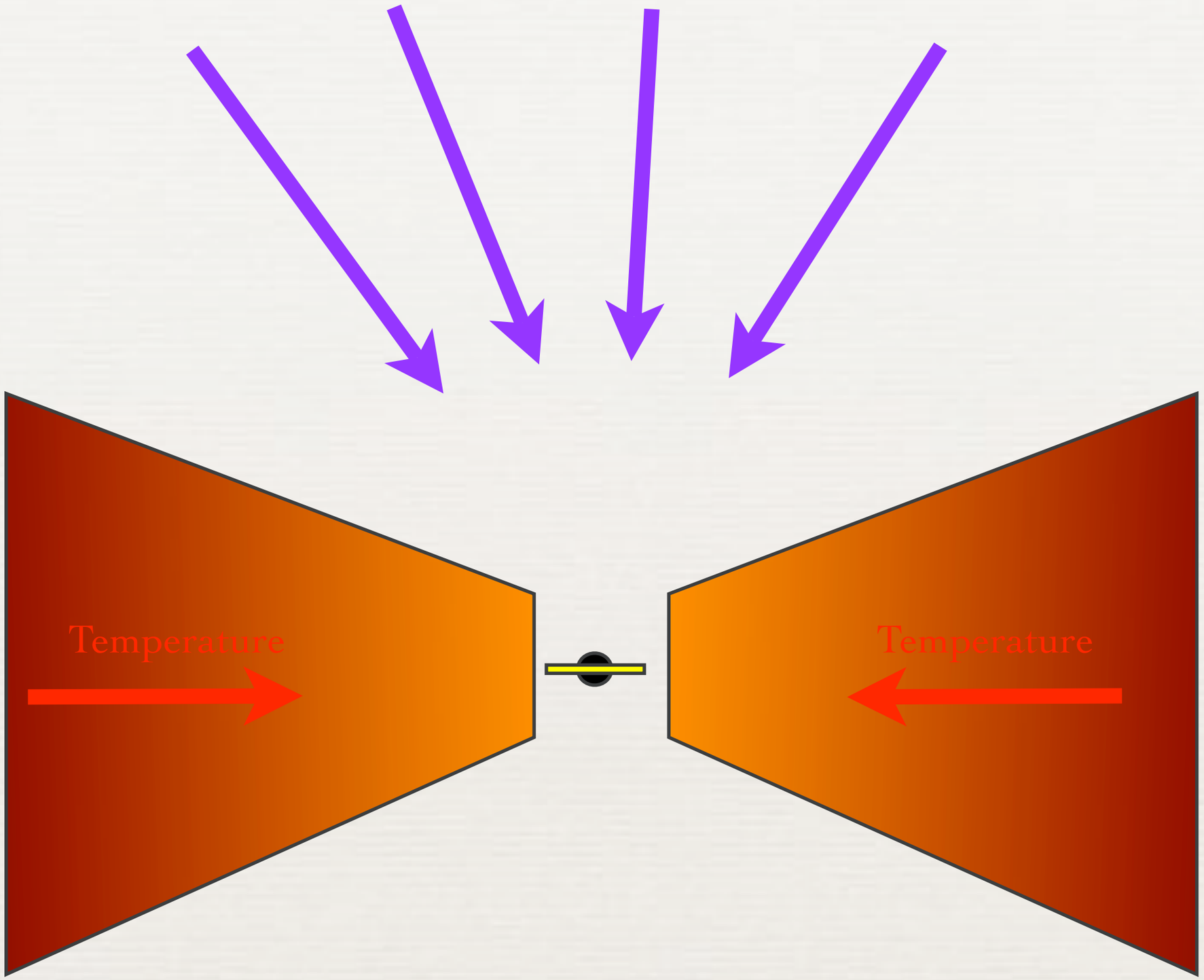
Find log-normal distribution of covering factors in QSOs

Compare to LE10 "warped disk" model

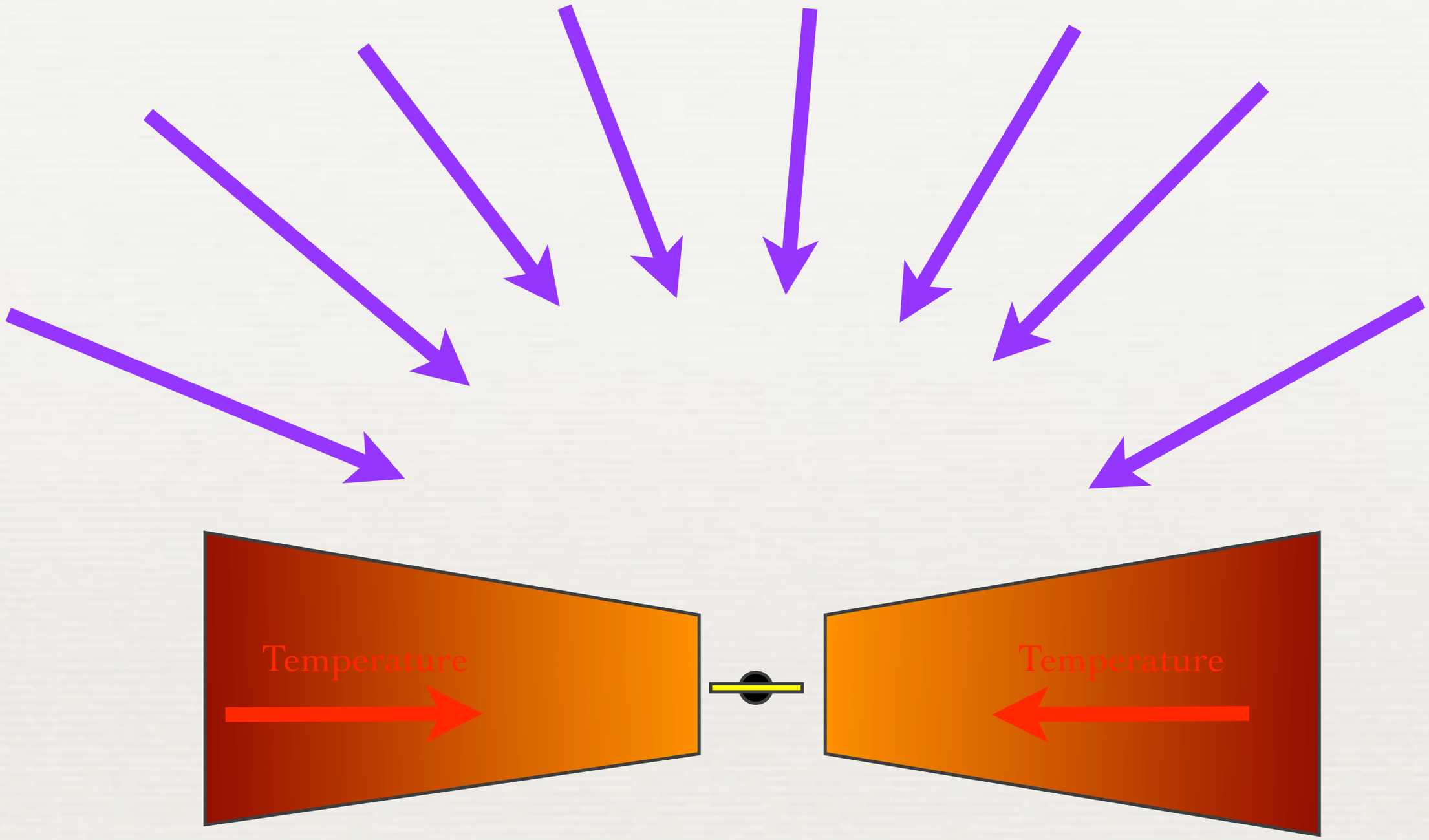




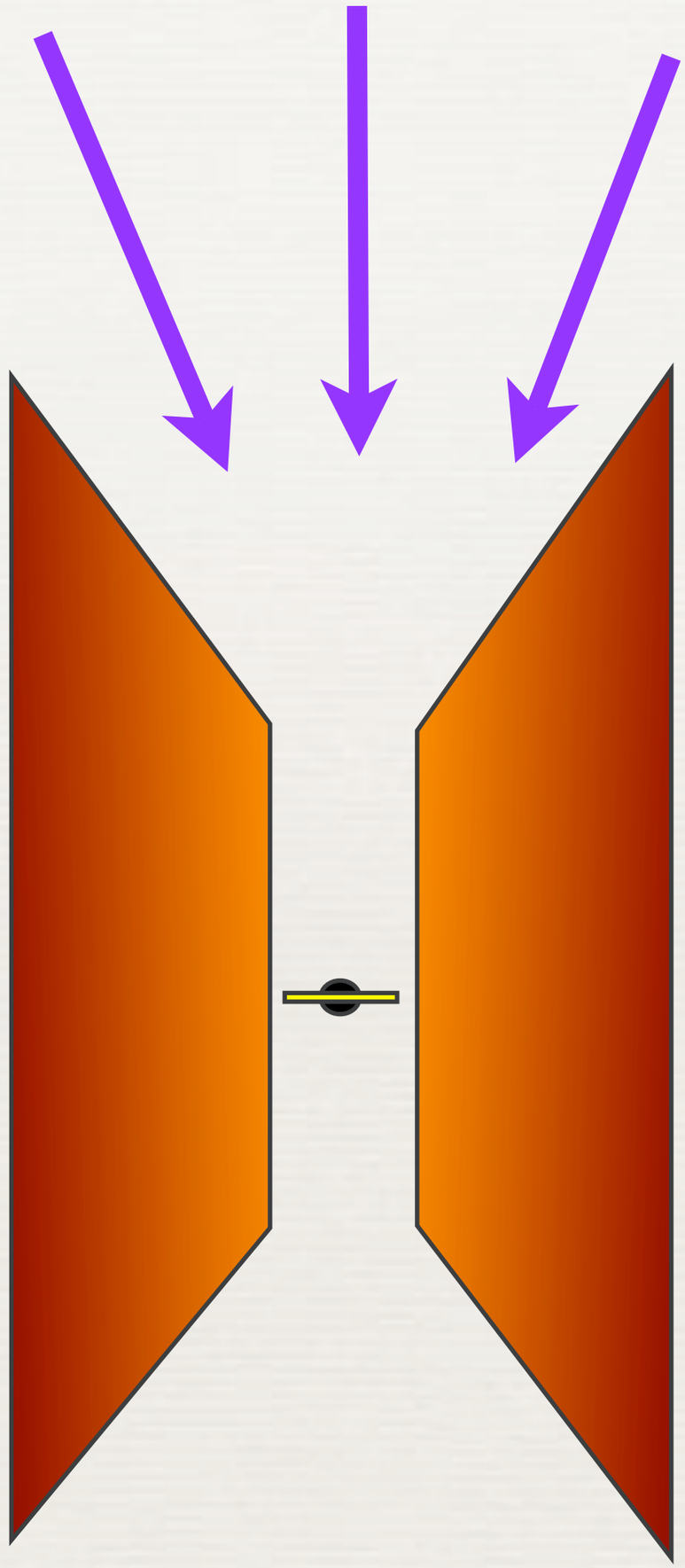
IR SED shape is correlated with covering factor;
low f_c -> hot IR SED



Typical covering factor



low covering factor



High covering factor

Conclusions

- Measure covering factors for ~10k QSOs from WISE-UKIDSS-SDSS
- Covering factors obey log-normal distribution with a mean of ~0.33 and dispersion of ~0.2 dex
- Observe a correlation between covering factor and IR SED shape; “hot” IR SEDs are associated with low covering factor (and vice-versa)