QSO SEDs as seen by WISE-UKIDSS-SDSS

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

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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 (1-3 $\mu$m) is found to be high ($\sim 40$ per cent), and dependant on covering factor.

Key words: quasars: general, infrared: general

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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?

Clumpy torus

Dullemond et al.
Accretion disk winds? (e.g. Elitzur 2002)

Artwork Credit: NASA, and M. Weiss (Chandra X-ray Center)
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 @ 4Mpc 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”
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 $L_{\text{bol}}>10^{46}$)
- ~25k have UKIDSS LAS overlap
- ~10k have WISE detections at 4 IR-bands
SDSS
UKIDSS
WISE
Clumpy torus model (Nenkova 2008)
Clumpy torus model (Nenkova 2008)

SDSS
UKIDSS
WISE

Elvis 1994
QSO mean SED
Clumpy torus model (Nenkova 2008)

Modified black body

Elvis 1994 QSO mean SED
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)