# Space Density of Optically-Selected Type 2 Quasars

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Abstract
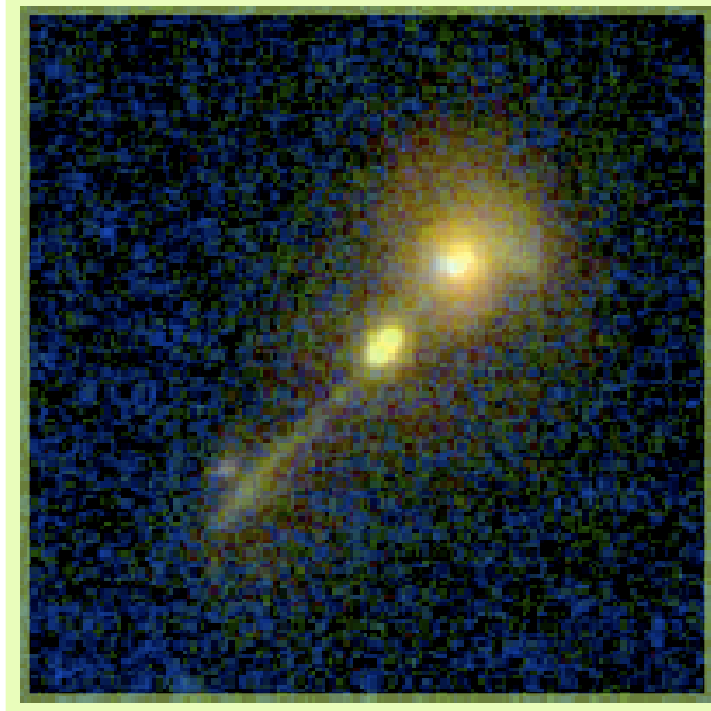
❖ *Fig.1.* Image of host galaxy of a type 2 quasar (taken with the ACS on the *HST*; Zakamska et al. 2006)

Type 2 quasars are luminous, obscured active galactic nuclei (AGN).

★ We selected **887 type 2 quasars** from the SDSS, based on their **narrow emission lines**.

➡ with redshifts **z<0.83** and [OIII]5007 luminosities **~10^8 - 10^{10} L$_\odot$** (bolometric luminosities ~ few x 10^{45} - 10^{47} **erg/s**).

★ We determined the **[OIII] luminosity function** and the equivalent luminosity function for SDSS **type 1** (unobscured) **quasars**.

➡ **type 2-to-type 1 quasar ratio** to be at least **1.2 : 1** for the highest luminosities.
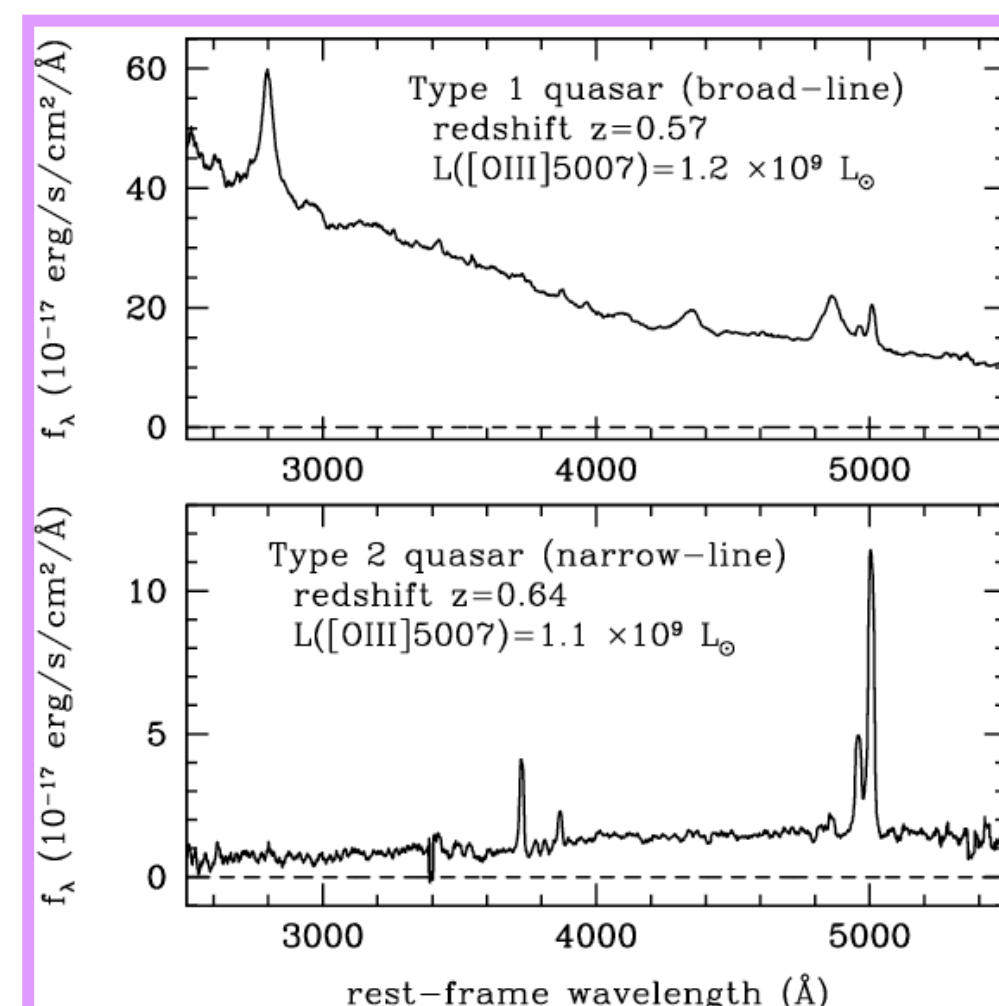
Introduction

★ Unification model of AGN: **orientation** governs whether a quasar appears as:

 · **Type 1:** blue, X-ray bright, *with broad emission lines*; or

 · **Type 2:** optically faint, *with only narrow emission lines*, high column densities in X-rays, high IR/optical ratio

★ Previous catalog of 150 optically-selected type 2 quasars (Zakamska et al. 2003) **confirmed to be obscured quasars by multiwavelength studies**: polarimetry, optical, X-ray and infrared observations.

❖ *Fig. 2.* Typical optical spectra of type 1 and type 2 quasars.

★ Determining the **obscured quasar fraction** has implications for:

· relating the *present mass density of black holes to the accretion history of quasars*

· understanding the *origin of the cosmic X-ray background*

· studying the *effects of luminosity on AGN structure*

Sample Selection

★ Type 2 quasars must have:

· **no broad emission lines**

· **luminous [OIII] emission** (L$_{[OIII]}$ > 10^8 L$_\odot$)

· sign of **hard ionizing emission**: line diagnostic diagrams ([OIII]/Hβ, [NII]/Hα, [SII]/Hα for z<0.3); high ionization lines ([NeV] for z>0.3)

★ Type 1 quasar sample:

· 8003 objects from the SDSS DR5 Quasar Catalog, selected based on their blue colors (with redshifts z<0.83)
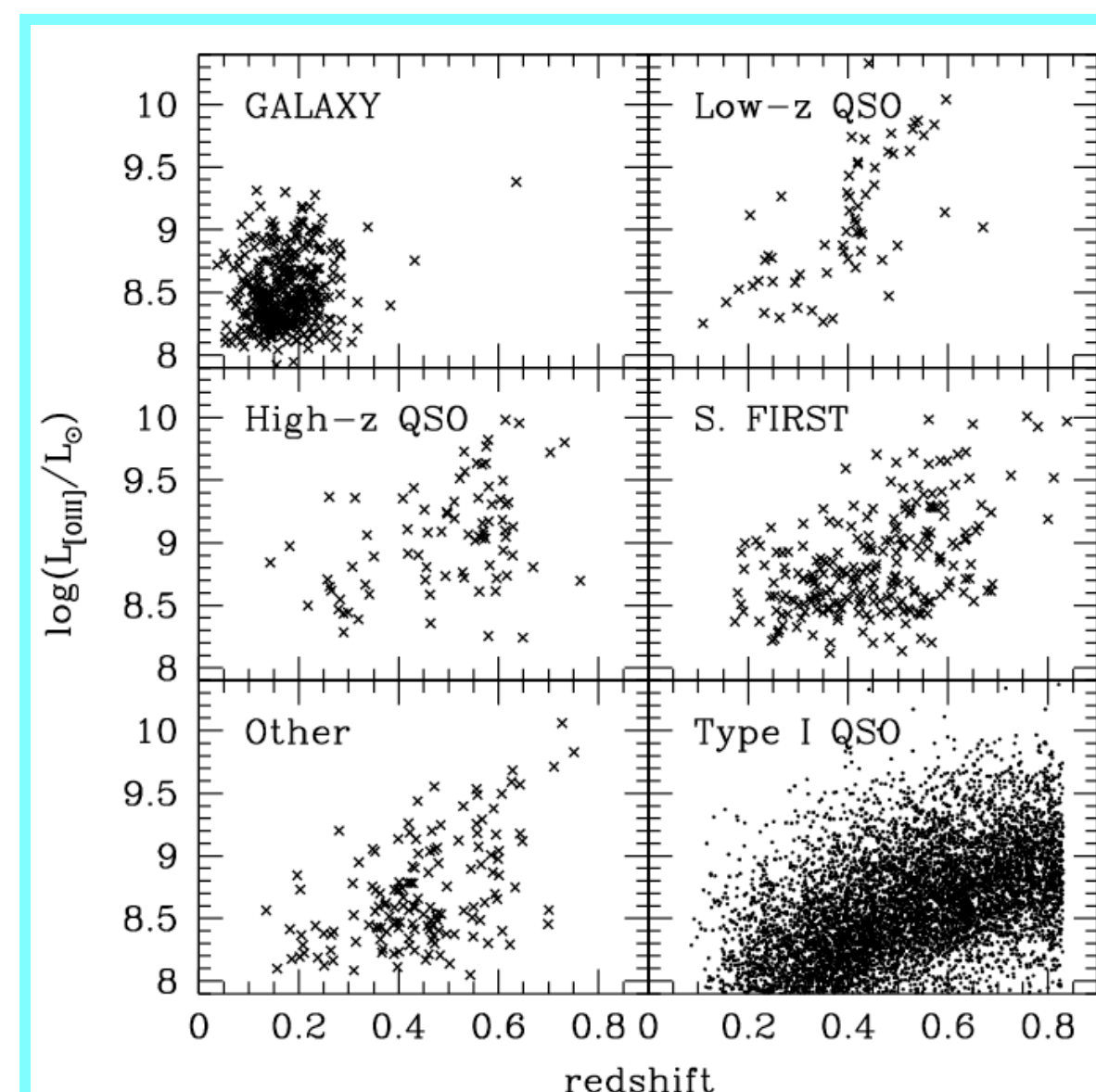
❖ *Fig. 3.* L$_{[OIII]}$ - redshift distribution for type 2 quasars (for the various SDSS target algorithms) and type 1 quasars.

Results

Luminosity Function

★ Volume-weighted (**1/V$_{max}$**) luminosity function (Schmidt 1968)

· Place object at different redshifts and check if it still meets SDSS target selection criteria.

· V$_{max}$ = volume over which object would be selected

★ The type 2 quasars have **complicated selection functions** (several spectroscopic target selection algorithms involved).

★ To minimize effect of redshift evolution, we use three redshift bins.
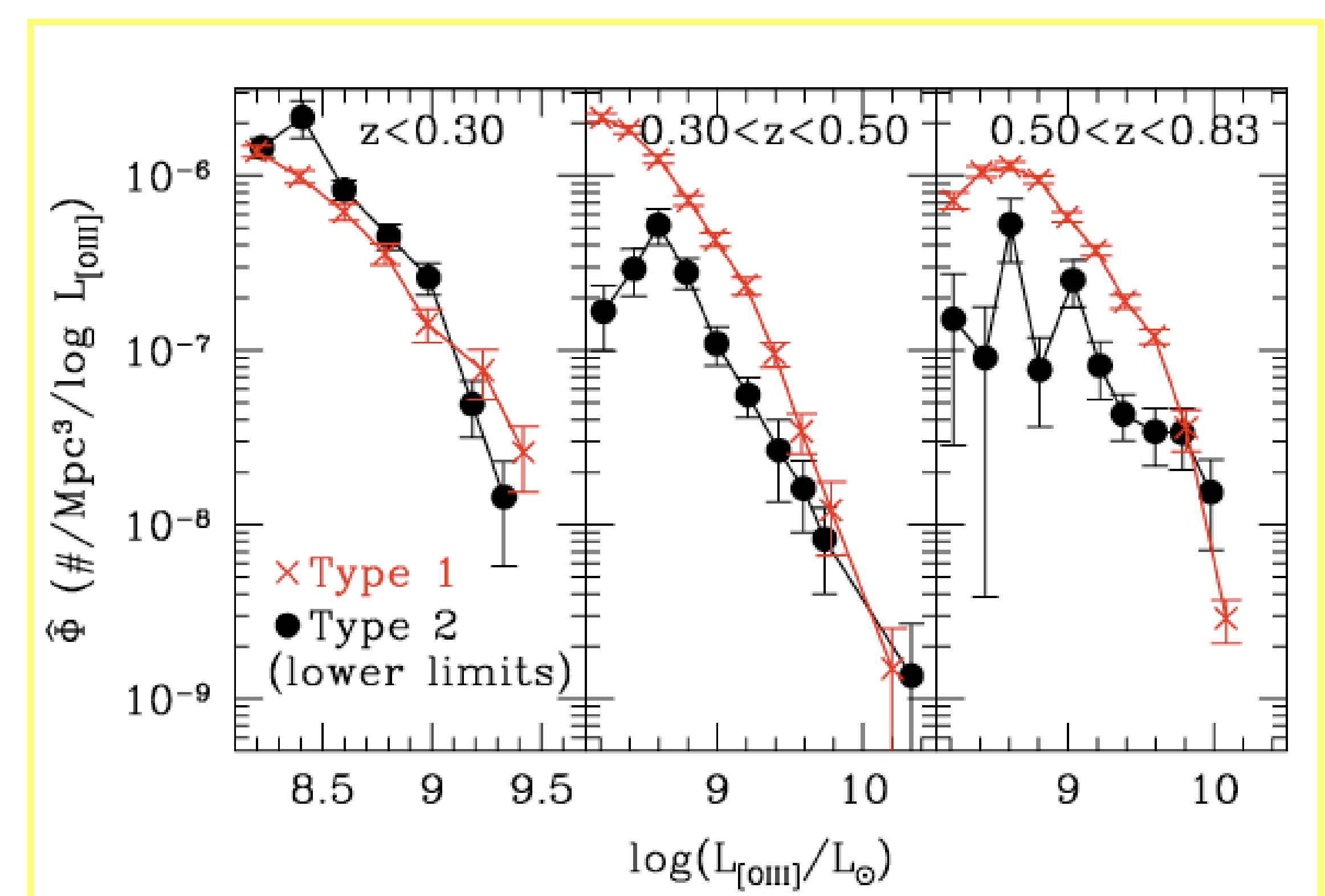
❖ *Fig. 4.* Volume-weighted [OIII] **luminosity function of type 1 quasars** (red crosses) and **type 2 quasars** *(lower limits*; black circles*)* for three ranges in redshift. The type 1 LF agrees with previous measurements (e.g., Richards et al. 2006).

Type 2 Quasar Fraction

★ Ratio of type 2-to-total (type 1 + type 2) number densities

· We integrate the luminosity functions over bins in [OIII] luminosity to determine number densities

★ **Lower limits** for several reasons:

· the *sample is incomplete* (some categories of objects do not satisfy our emission line criteria).

· *no reddening correction is applied* ([OIII] luminosities underestimated).

★ Strongest lower limits derived where *sample is most complete*:

· z<0.3, low L$_{[OIII]}$

· z>0.3, highest L$_{[OIII]}$

★ *Most of the quasars in the local Universe are obscured.*
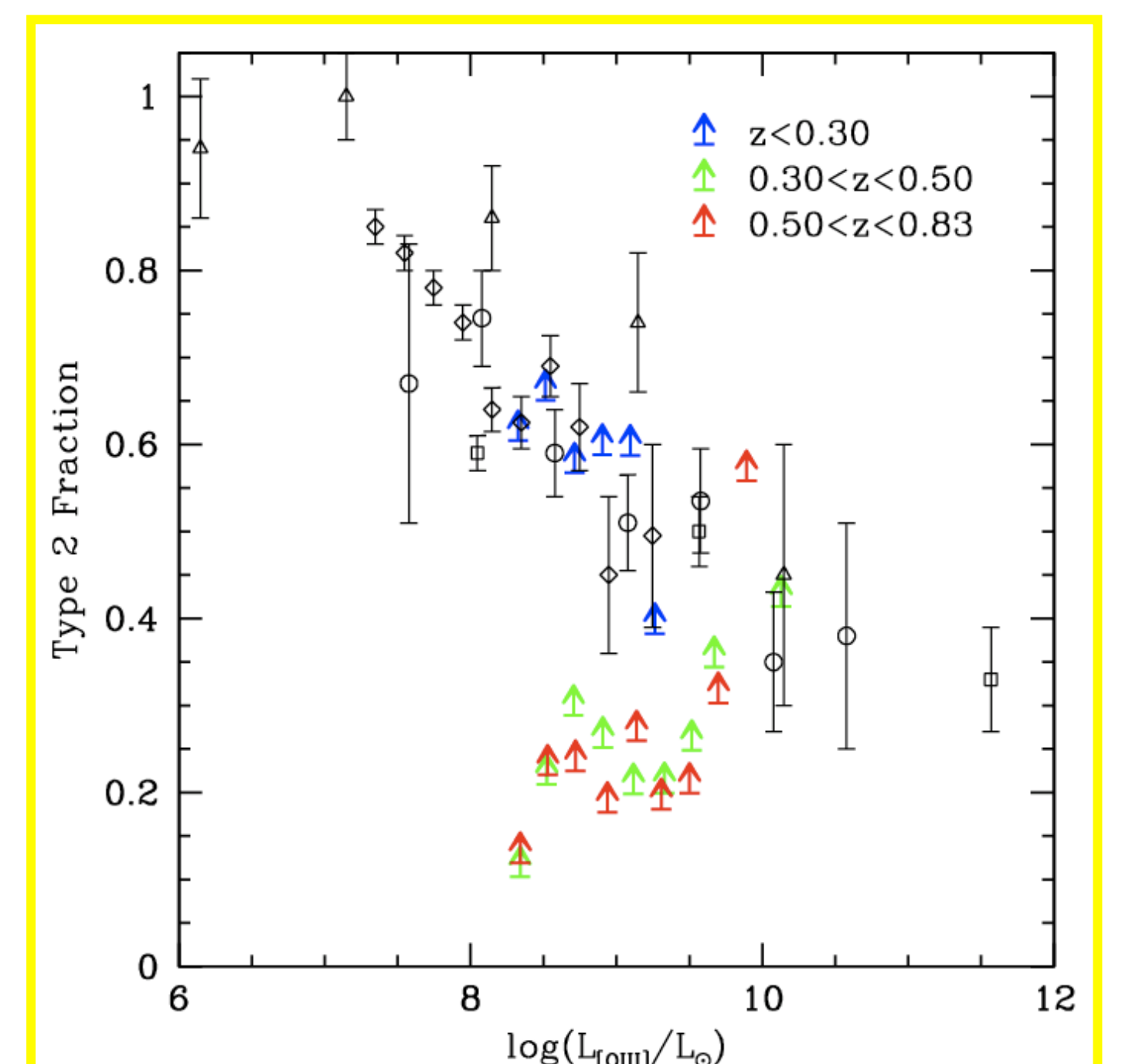
❖ *Fig. 5.* **Type 2 quasar fraction *(lower limits)*** in bins of [OIII] luminosity for three ranges in redshift (blue, green, and red arrows); other work from X-ray observations: Ueda et. al. (2003, open squares), Hasinger (2004, open circles), Grimes et. al. (2004, open triangles) and optical observations: Simpson et. al. (2005, open diamonds).