High resolution spectroscopy of Ne II emission from young stellar objects

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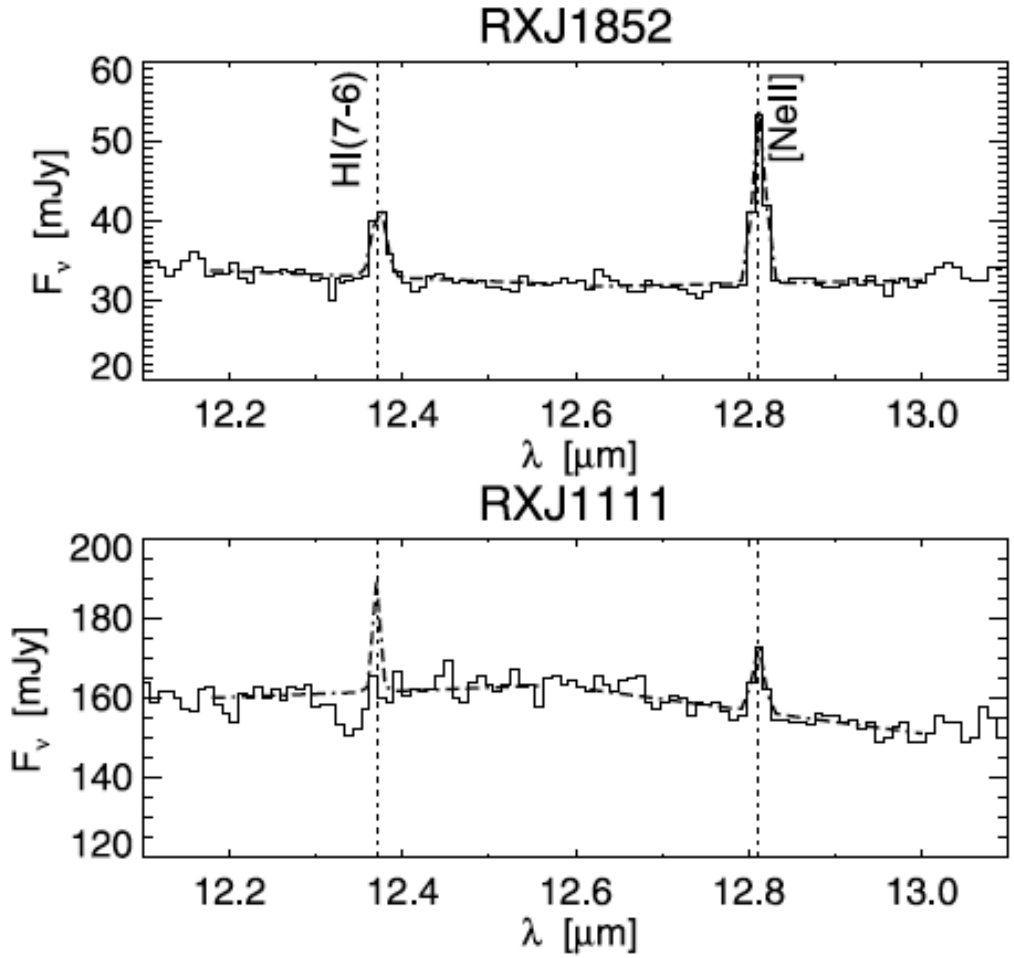
Ne II emission at 12.81 μm: a powerful tracer of the effects of high energy emission on disks

1. Neon is ionized either by EUV (E>21.6 eV) produced in the accretion shock (e.g. Alexander et al. 2008) or by coronal X-rays (E>0.9 keV) (e.g. Glassgold et al. 2007, Ercolano & Owen 2010);
2. Line collisionally excited traces the warm (T~5000 K) inner disk (Ercolano & Owen 2010);
3. Ne II emission at 12.81 μm has been detected in several YSOs using the Spitzer/IRS spectrograph (Pascucci et al. 2007; Lahuis et al. 2007, Flaccomio et al. 2009, Gudel et al. 2010)



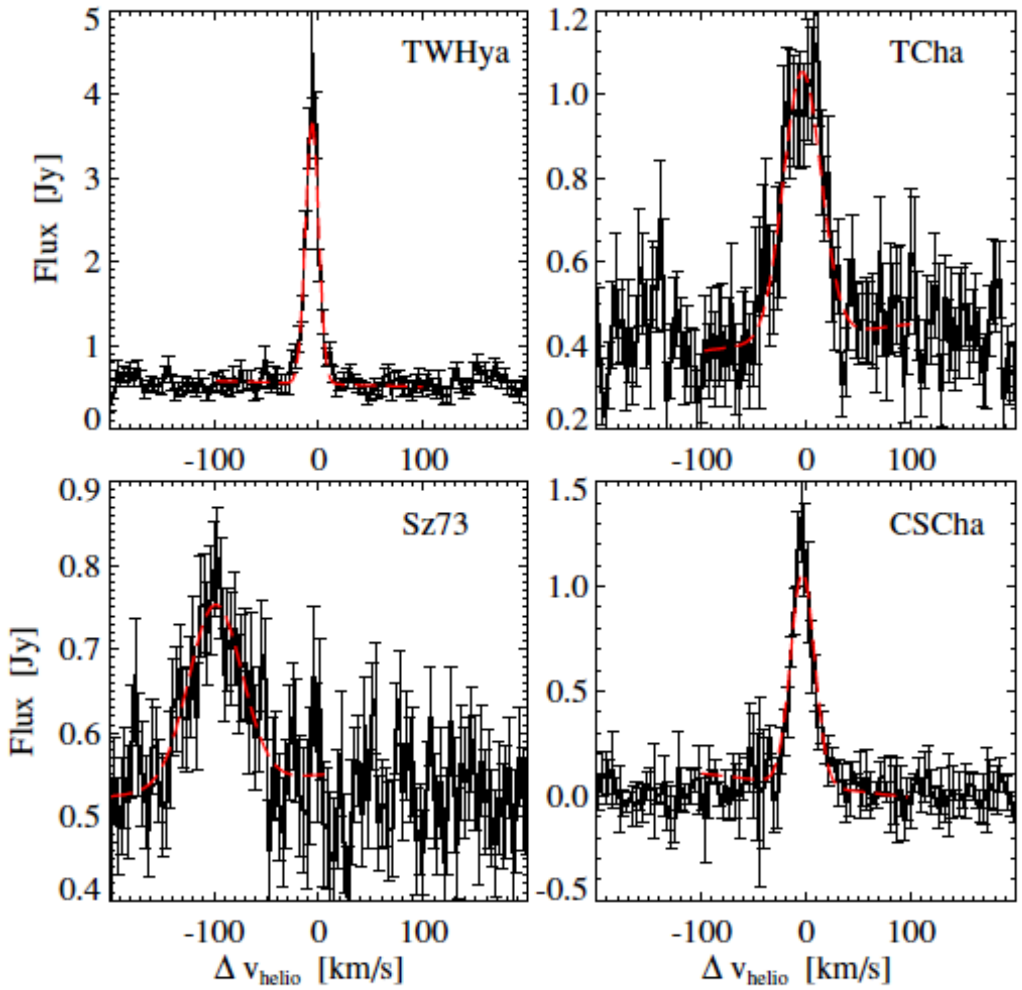
(Pascucci et al. 2007)

Origin of the Ne II emission at 12.81 μm in YSOs: different hypothesis

1. X-ray (or EUV) irradiated inner (r < 30 AU) disk (e.g. Ercolano & Owen 2010, Pascucci & Sterzik 2009). Small line blue-shift (v<10-15 km s^{-1}) and small line width (Δv ~20 km s^{-1}), correlation between disk inclination and line width;

2. Shock-heated gas in protostellar jets (e.g. Hollenback & McKee 1989, Van-Boeckel et al. 2009). Extended emission, large blue-shift (v~100 km s^{-1}) and line width (Δv ~50–100 km s^{-1}), correlation between mass accretion rate and line luminosity.

3. Magnetically accelerated X-wind irradiated by stellar X-ray emission (Shang et al. 2010). Large blue-shift (v~100 km s^{-1}) and line width (Δv ~50–100 km s^{-1}), correlation between mass accretion rate and line luminosity.



(Pascucci & Sterzik 2009)

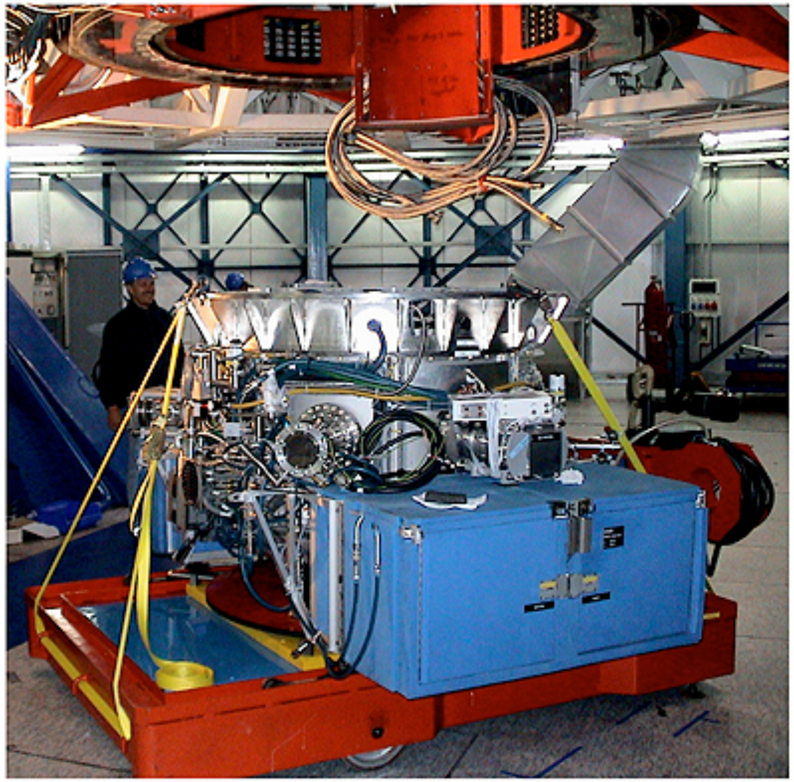
High resolution spectroscopy of Ne II emission from YSOs

Targets: 32 YSOs of different classes(9 class I, 13 class II, 10 transition/pre-transition disk), belonging to different Star forming regions;

Target distance: between 40 to 150 pc

Instrument: VLT/VISIR, spectral R=30,000, spatial resolution, 0.4 arcsec

Observations: ~7 nights in three observing periods



VISIR under the Cassegrain Focus of the 8.2-m VLT Melipal Telescope

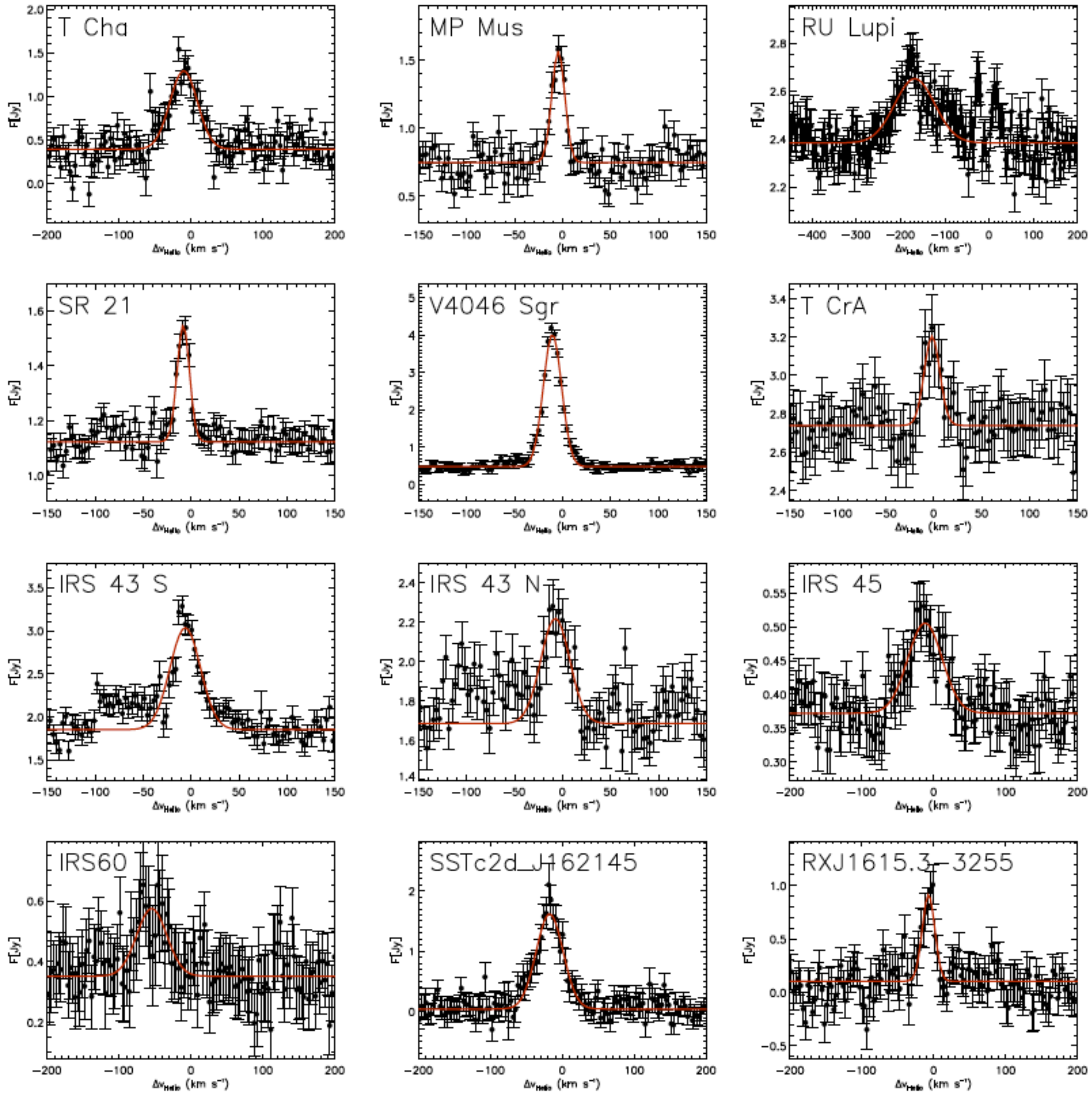
ESO PR Photo 16a/04 (12 May 2004)

High resolution spectroscopy of Ne II emission from YSOs

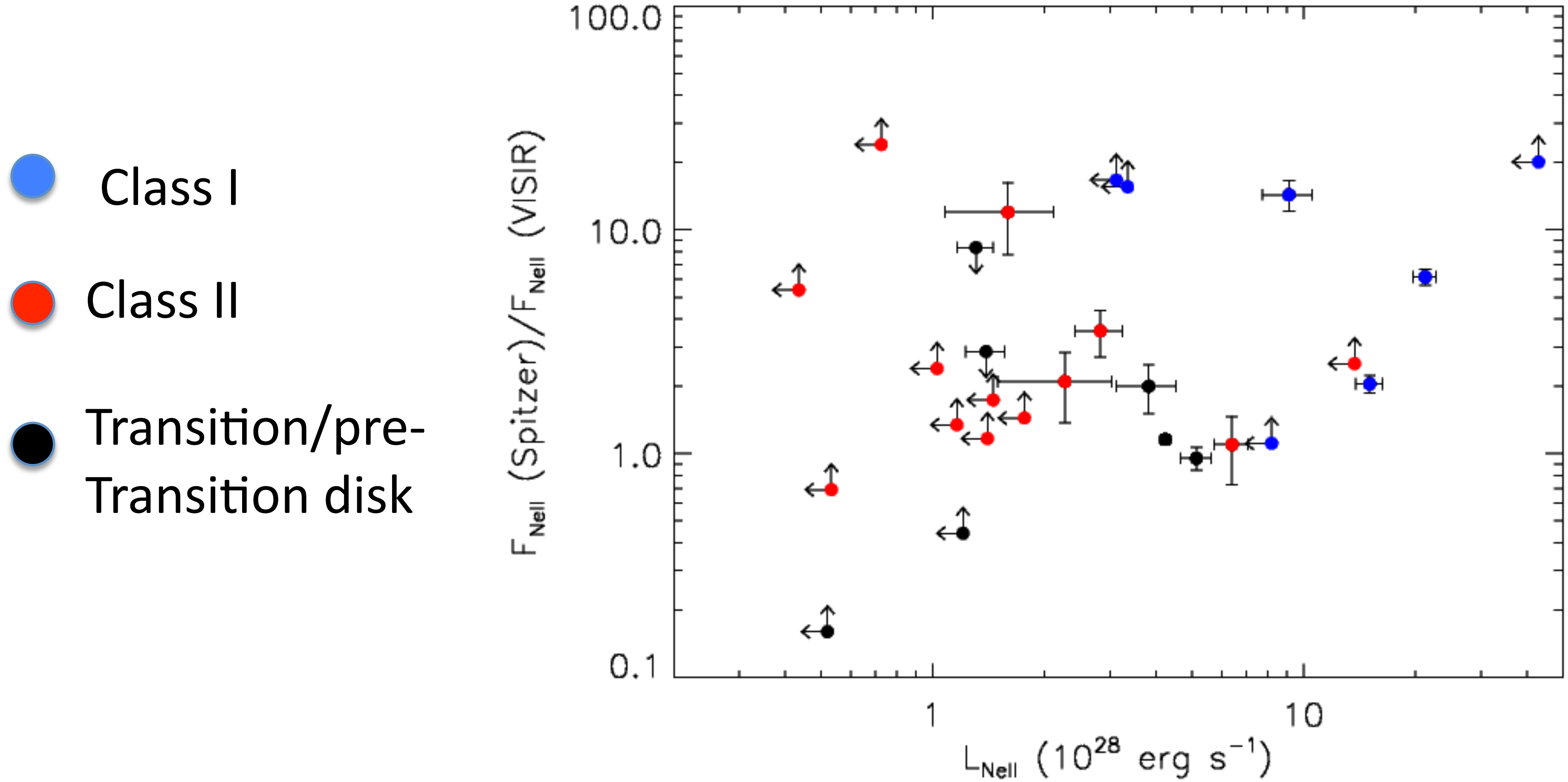
- 12 detections (number of detections by high resolution spectrographs more than tripled)

- Emission within 20-40 AU from the central star (i.e. no spatially extended emission has been detected)

(Sacco et al. 2012, ApJ, 747, 142)



Ne II fluxes: VISIR vs. Spitzer



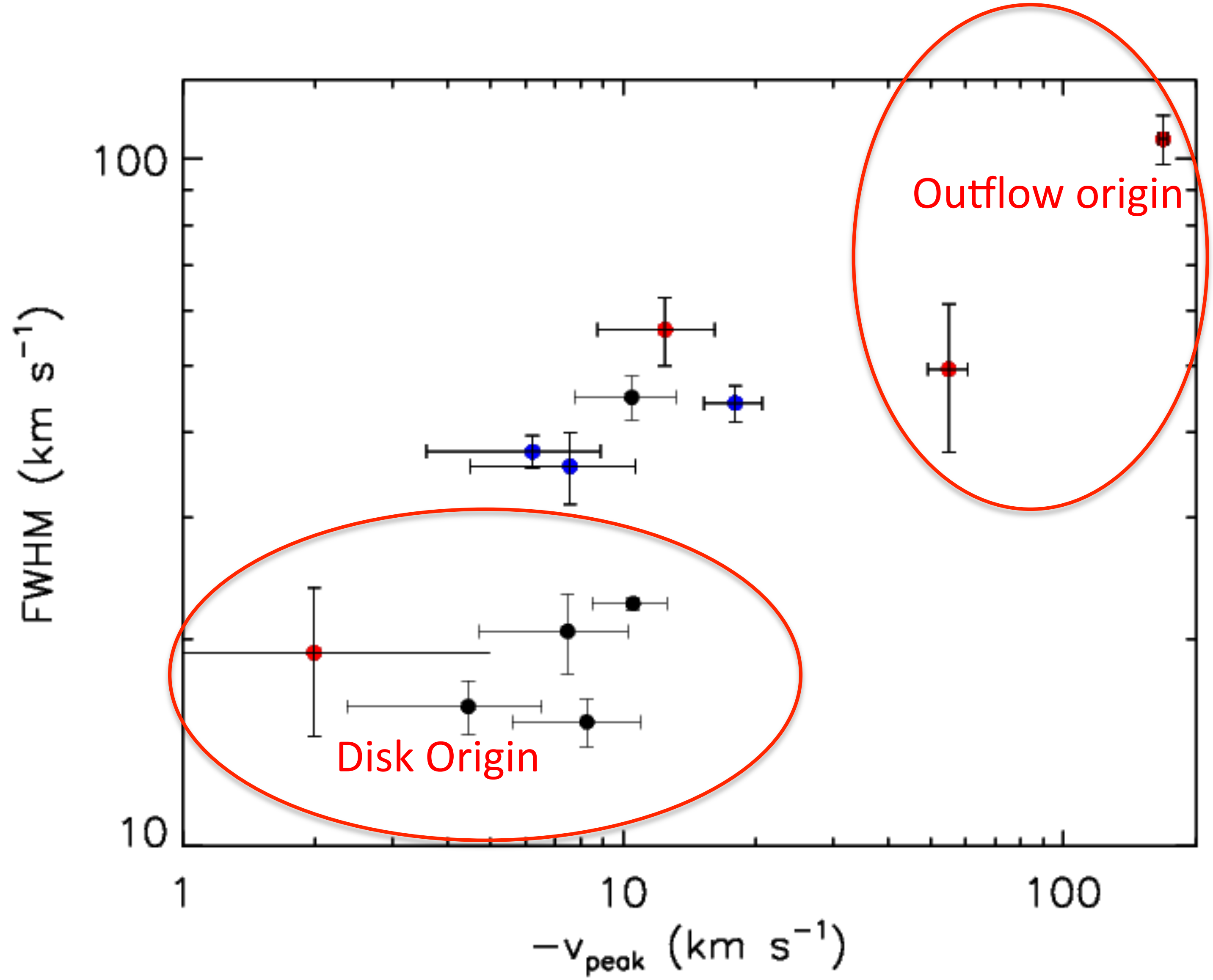
- Class I sources: Spitzer/IRS fluxes higher than VLT/VISIR fluxes;
- Transition/pre-Transition disk: Spitzer/IRS fluxes in agreement with VLT/VISIR fluxes; (Sacco et al. 2012, ApJ, 747, 142)

FWHM vs. line blue-shifts

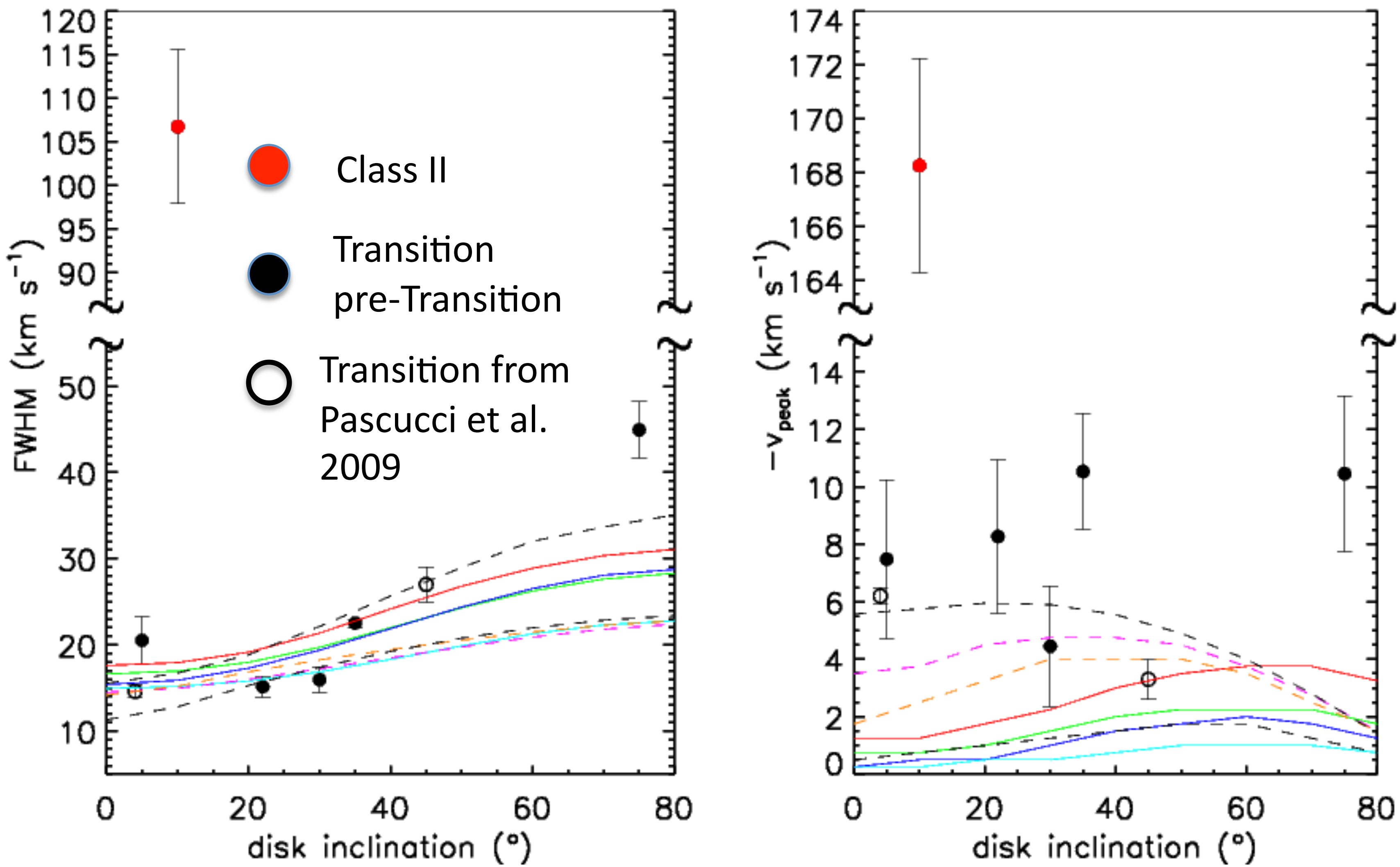
Class I

Class II

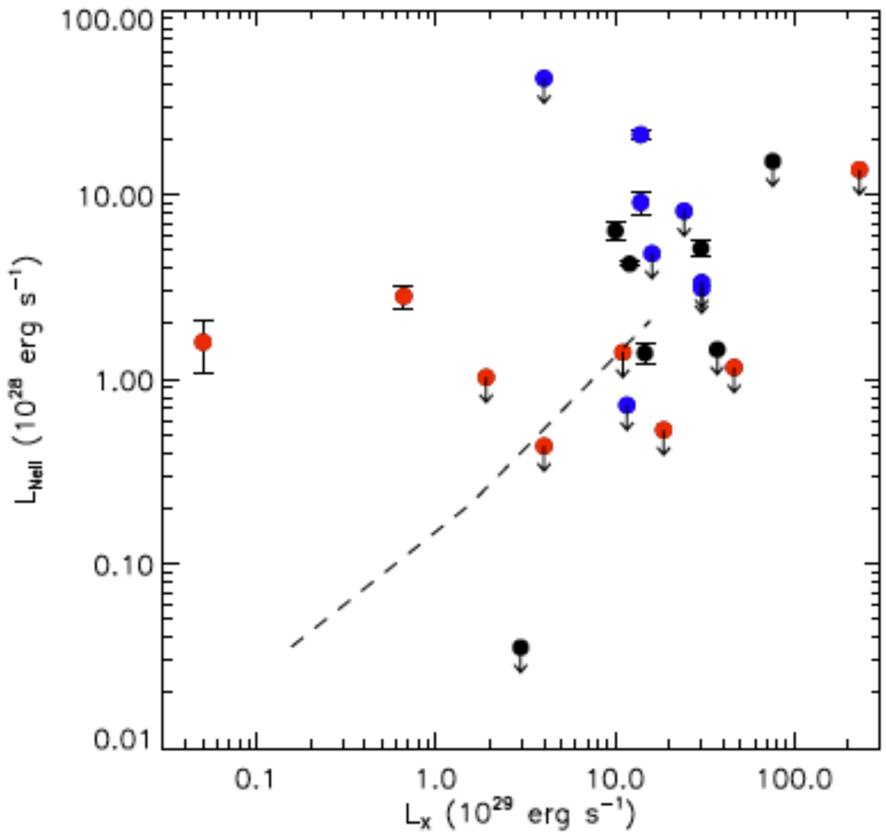
Transition
pre-Transition

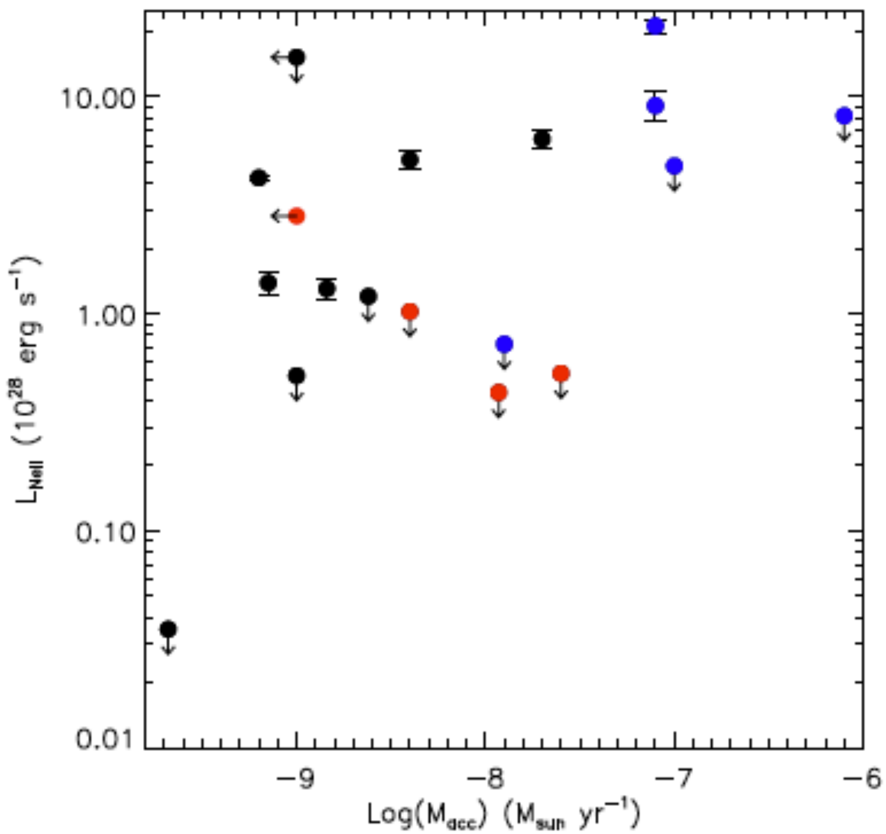


FWHM and Blue-shift vs. disk inclination



Ne II Fluxes vs. X-ray luminosities and mass accretion rates





(Sacco et al. 2012,ApJ, 747, 142)

Conclusions

We observed 32 YSOs, using the high resolution mid-infrared spectrograph VLT/VISIR, with the aim of studying the origin of the Ne II emission at 12.81 μm. We obtain the following main results:

- we detected the emission in 12 YSOs;
- in Class I objects the emission is mainly due to shock in the extended circumstellar envelope, while in transition and pre-transition disk the emission is produced from the inner disk ;
- the emission is always blue-shifted, confirming that the inner disk is photoevaporating;
- we do not find a correlation between Ne II luminosity and X-ray emission, because of heterogeneity of the observed disks;