Interpreting H_2 and [OI] line emission of T Tauri disks with photo-evaporative disk wind models

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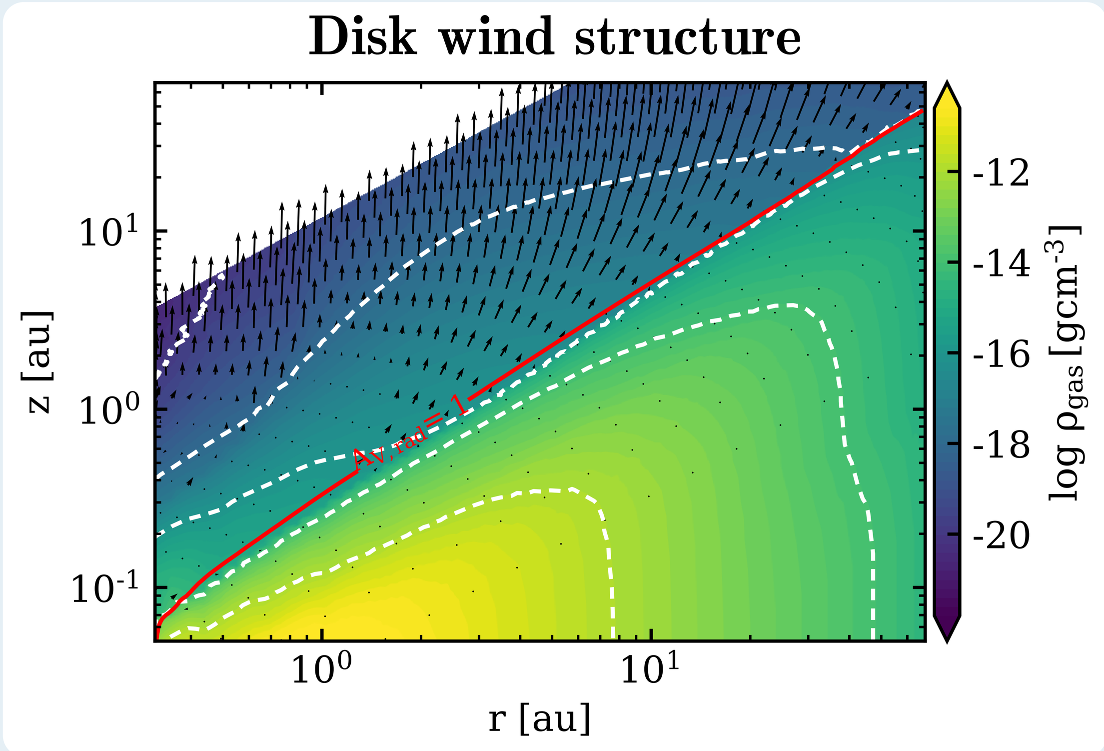
Context

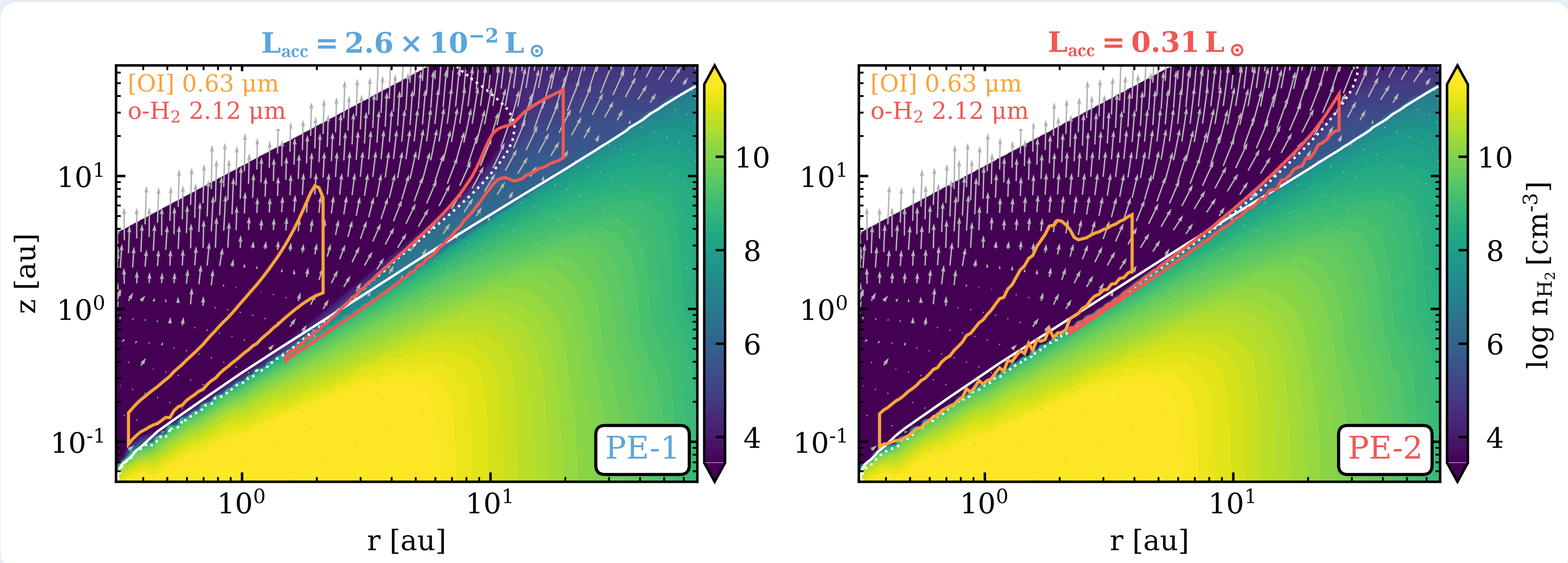
- recent observational data show signatures of disk winds in both atomic & molecular species (Gangi et al. 2020)
- many theoretical models for both thermally or magnetically driven winds exits, but a direct comparison of those models to observations is challenging (e.g. computationally expensive, thermo-chemistry, ...)
- here we present an efficient approach that allows for a direct comparison of photo-evaporative disk wind models to observations of the atomic ([OI] 0.63 μm) and molecular tracers (H_2 2.12 μm)

Method



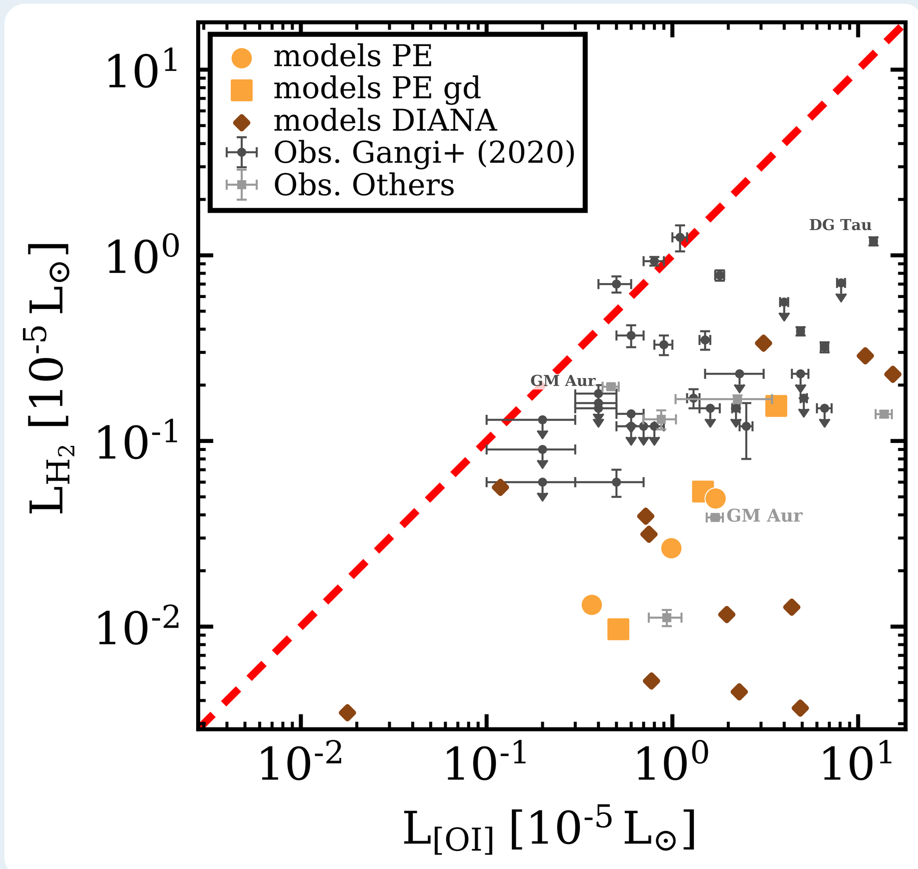
- physical disk/wind density structure and velocity field from 2D EUV/X-ray photo-evaporative disk wind models (Picogna et al. 2019; Weber et al. 2020)
- post-process models with the radiation thermo-chemical disk code ProDiMo (e.g. Woitke et al. 2009; Kamp et al. 2010; Thi et al. 2011) to self-consistently calculate the thermal/chemical structure and spectral line profiles

Origin of line emission



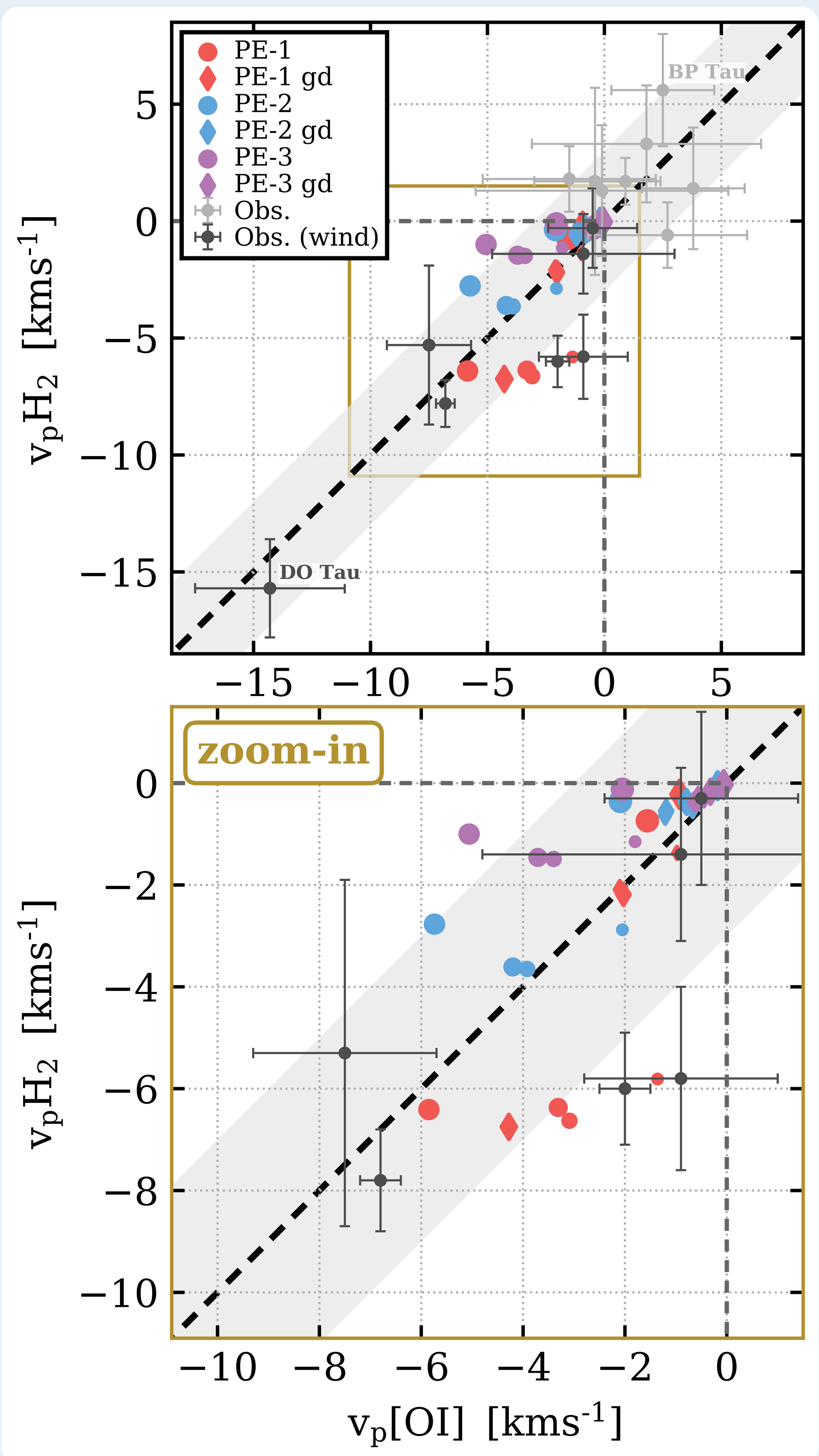
- line emitting regions for the H_2 (red box) and [OI] (orange box) spectral lines
- H_2 can survive in the wind region; depends on the far-UV flux (i.e. lower accr. lum. more H_2)
- H_2 is emitted closer to the disk surface and from larger disk radii compared to [OI]

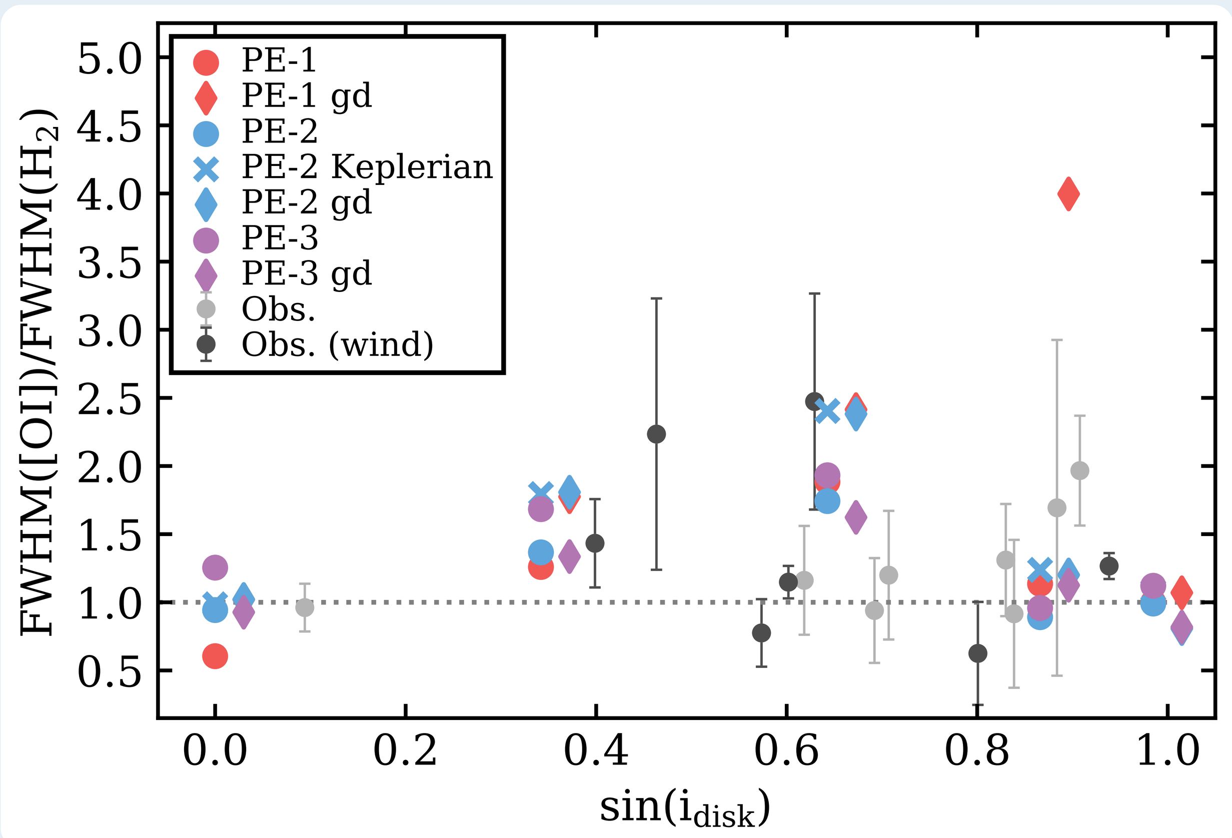
Line luminosities



- line lums. are in good agreement with obs.; orange: wind models; brown: no wind models
- tendency to underestimate H_2 line luminosities

Line kinematics (wind signatures)





- obs. data is usually fitted by Gaussian components to identify high/low velocity components and shift in the peak emission of the line ($\mathbf{v_p}$) (e.g. Banzatti et al. 2019; Gangi et al. 2020); e.g. blue-shifted $\mathbf{v_p}$ $\rightarrow$ disk wind
- use same procedure for synthetic observables (*coloured symbols* are the models)
- good agreement for the narrow low-velocity component ($v_p \approx$ few km/s) for both v_p and the full-width half-maximum (FWHM) of both modelled lines
- similar measured v_p and FWHM for both lines do not necessarily indicate same physical origin of line emission; *reasons:* complex wind vel. structure; thin-disk approx. to determine emission radius

Summary & Outlook

- efficient modelling approach to directly confront (magneto) hydrodynamic disk wind models to observations of molecular and atomic wind tracers
- photo-evaporative disk wind models are consistent with the observed line kinematics for the [OI] 0.63 μm & H_2 2.12 μm narrow low-velocity line components
- determination of physical line origins from observations requires modelling due to complex disk/wind structure and limited spatial & spectral resolution of observations

Outlook

- apply procedure to MHD disk wind models
- other molecular wind tracers (CO ro-vib)
- prediction for future instruments with higher spatial & spectral resolution (e.g. METIS/ELT)

References

• Banzatti, A., et al. 2019, ApJ, 870, 76 • Gangi, M., et al. 2020, A&A, 643, A32 • Kamp, I., et al. 2010, A&A, 510, A18 • Picogna, G., et al. 2019, MNRAS , 487, 691 • Thi, W.-F., Woitke, P., & Kamp, I. 2011, MNRAS , 412, 711 • Weber, M. L., et al. 2020, MNRAS , 496, 223 • Woitke, P., Kamp, I., & Thi, W.-F. 2009, A&A, 501, 383