A multi-frequency and wide-band absorption line study using the KVN+Effelsberg+Yebes (KEY) array

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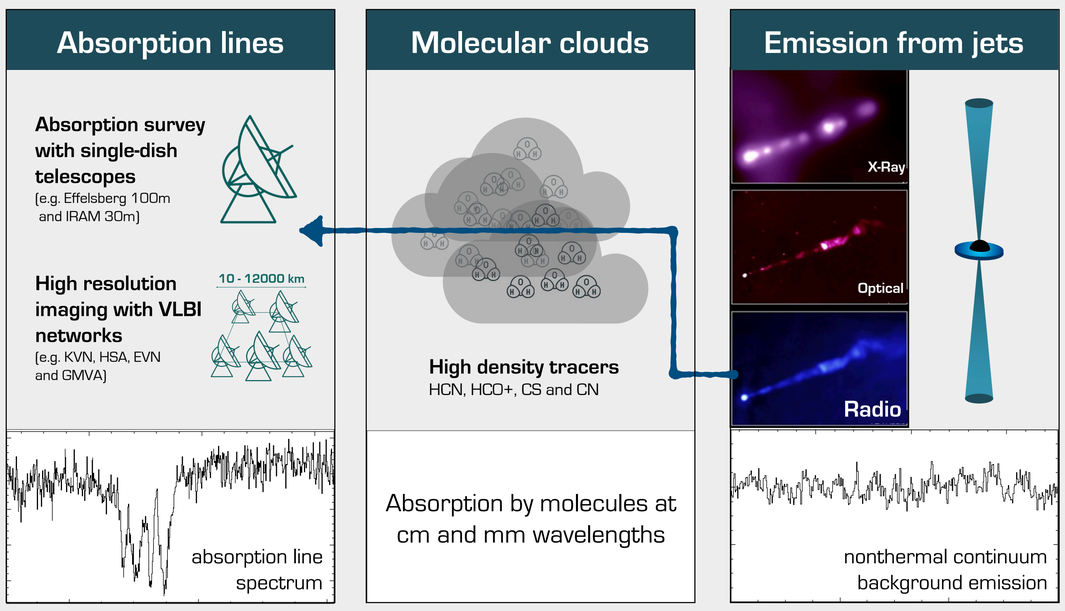
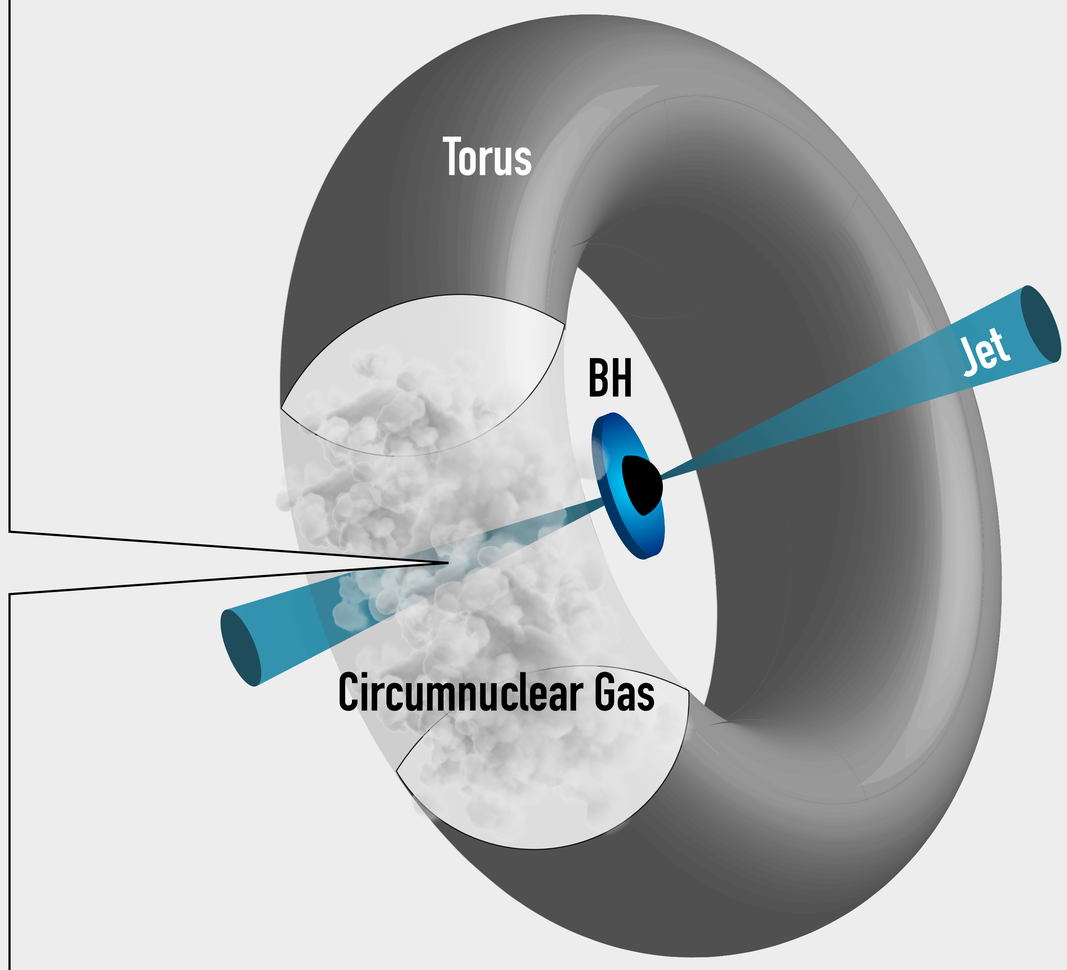
Abstract: Atomic or molecular absorption lines seen by background jet emission are unique probes, allowing us to study circumnuclear gas in active galactic nuclei. (AGN). In previous studies, high-resolution VLBI observations towards HI (21-cm) absorption hint at the presence of circumnuclear gas in the innermost region of radio AGN. Further spectral line VLBI experiments using molecular absorption lines at higher frequencies provide better angular resolutions and help to constrain gas properties. However, strong standing waves and radio frequency interference (RFI) present in single-dish observations hinder detecting various molecular absorption lines in radio AGN. To find molecular absorption lines in some young radio AGN, we have conducted an absorption line survey with a small VLBI array equipped with a wide-band backend and/or multi-frequency receiver system. Time-averaged cross-power spectra effectively eliminate standing waves and RFI, and thus allow us to detect weak absorption features. This poster briefly introduces the motivation of our project using the KVN+Effelsberg+Yebes (KEY) array and preliminary results.

The origin of molecular absorption in AGN

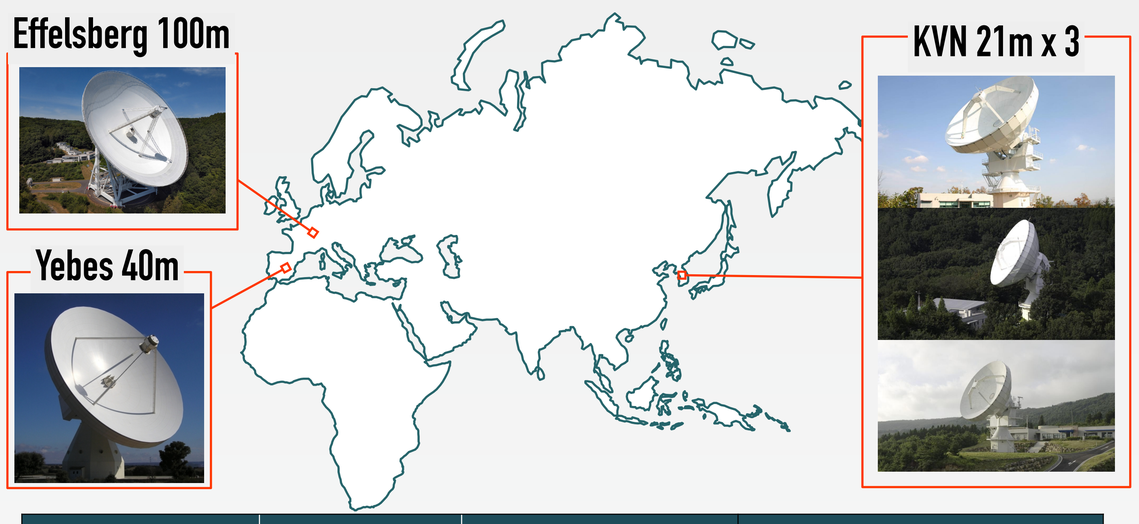




Why absorption and VLBI?

- Detect molecular cldous at high z with much more sensitivity (down to 1 $M_\odot$) than with emission searches
- Reach sub-pc scales via absorption line VLBI imaging
- VLBI line observations effectively avoid stranding waves and RFI

KEY (KVN + Effelsberg + Yebes) Array



Telescope	Receiver type & band	Backend (recording rate)	Observation mode
KVN (21 m x 3)	Multi-band K / Q / W / D	OCTAD (Up to 32 Gbps)	K + Q Simultaneous 512 MHz + 512 MHz
Yebes (40 m)	Multi-band K / Q / W	DBBC3 (Up to 8 Gbps)	K + Q Simultaneous 512 MHz + 512 MHz
Effelsberg (100 m)	Single-band K / Q	DBBC2 (Up to 8 Gbps)	K or Q Switching 512 MHz + 512 MHz

Science goals

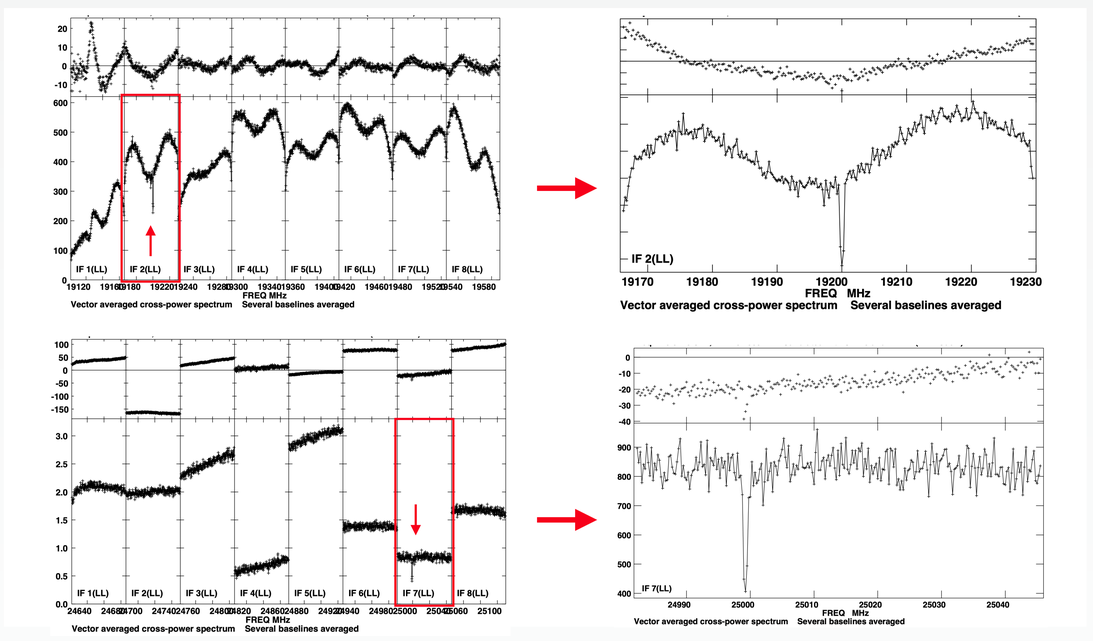
- Probe the matter reservoir around young radio AGN at high z (z > 1)
- Find a signature of molecular outflow or fueling flow
- Constrain physical and chemcial properties of the obscuring gas

Observations

Number of sources	Type	Flux density	Target Transitions	Obs time
7	GPS / HFP Candidates	> 100 mJy at K > 100 mJy at Q	HCN / HCO+ (J=2-1, 3-2, and 4-3)	6 - 8 hrs per source

Preliminary results

Target	Obs time	KY	KT	KU	YB	EB	Fringes	Note
J0017+5312	05 Sep. 2019	Y	Y	Y	Y	Y	Y	
J0642+6758	05 Sep. 2019	Y	Y	Y	N	Y	Y	
J0753+4231	05 Sep. 2019	Y	Y	Y	Y	Y	Y	
J0905+4850	05 Sep. 2019	Y	Y	Y	Y	Y	Y	
J1127+5650	Canceled	N	N	N	N	N	N	Cancelled
J1335+4542	05 Sep. 2019	Y	Y	Y	N	N	Y	K only for Eb EB
J1335+4542	05 Sep. 2019	Y	Y	N	Y	Y	Y	Q only for Eb EB
J1526+6650	05 Sep. 2019	Y	Y	Y	Y	Y	Y	



Future plan

- Phase transfer from K to Q band to improve baseline sensitivities
- Line identification for detected absorption features
- Imaging continuum jet emission and locate absorption features
- Follow-up spectral line surveys towards detected absorption systems

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