Probing multi-phase outflows and AGN feedback in compact radio galaxies: the case of PKSB 1934-63

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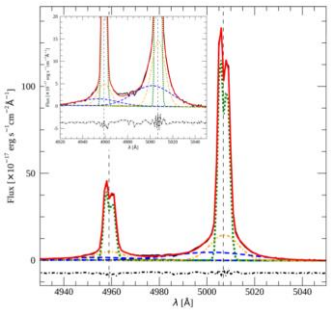
ABSTRACT

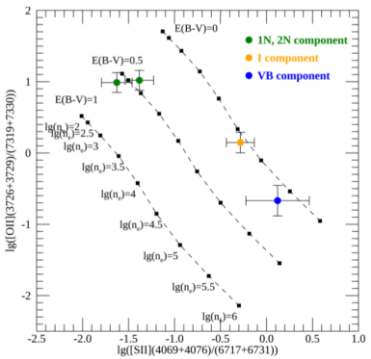
Young radio AGN are pivotal for our understanding of many of the still-debated aspects of AGN feedback. In this paper we present a study of the interstellar medium (ISM) in the compact, peaked-spectrum radio galaxy PKS B1934-63 using X-shooter observations. Most of the warm ionized gas resides within a circum-nuclear disk with a radius of about 200 pc that is likely to constitute the gas reservoir from which the central black hole feeds. On the other hand, we find a biconical outflow of warm ionized gas with an estimated radius of 59 ± 12 pc. This matches the radial extent of the radio source and suggests that the outflow is jet driven. Thanks to the superior wavelength coverage of the data, we can estimate the density of the warm ionized gas using the trans-auroral line technique, and we find that the outflowing gas has remarkably high density, up to $\log n_e$ (cm^{-3}) $\simeq$ 5.5. The estimated mass outflow rate is low ($\dot{M}$ =10^{-3}-10^{-1} M$_\odot$ yr^{-1}), and the AGN feedback operates at relatively low efficiency ($\dot{E}/L_{bol}$ ~ 10^{-4}-10^{-3}%). In addition, optical and near-IR line ratios show that the expansion of the radio source drives fast shocks (with velocities $v_s \gtrsim$ 500 km s^{-1}) that ionize and accelerate the outflowing gas.

At odds with the properties of other compact, peaked-spectrum radio sources hosting warm ionized gas outflows, we do not find signs of kinematically disturbed or outflowing gas in phases colder than the warm ionized gas. We argue that this is due to the young age of our source and thus to the recent nature of the AGN-ISM interaction, and suggest that cold gas forms within the outflowing material and the shock-ionized outflowing gas of PKS B1934-63 did not have enough time to cool down and accumulate in a colder phase. This scenario is also supported by the multi-phase outflows of other compact and young radio sources in the literature.

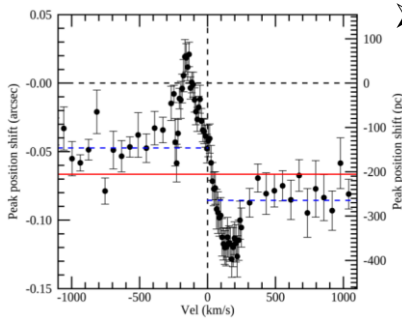
コンパクト電波銀河PKS B1934-63
X-shooter(UVB, VIS, NIR)で分光観測
warm電離ガスのoutflow
➢ サイズ・密度・outflow rate・効率
coldガスがない
➢ outflowの進化過程を考える



輝線を4成分に分解
➢ Double peakをもつ
密度推定(trans-auroral)
➢ Broad成分が高密度

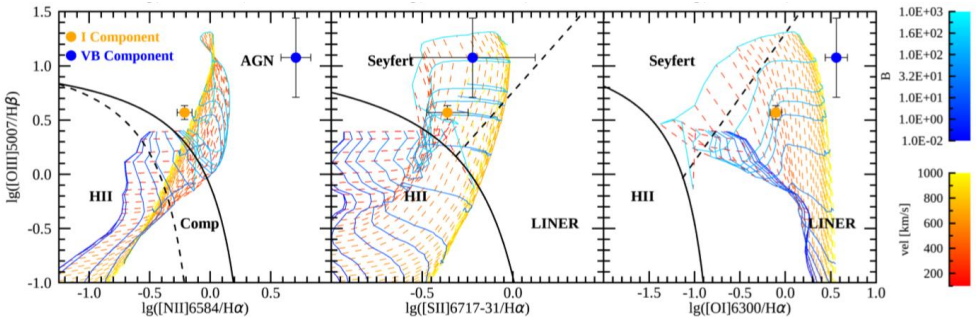


視線速度のpeak position
✓ |v|<250はS字
➢ Narrowはディスク
✓ |v|>250は一定
➢ Broadはアウトフロー
➢ 半径が~60pc

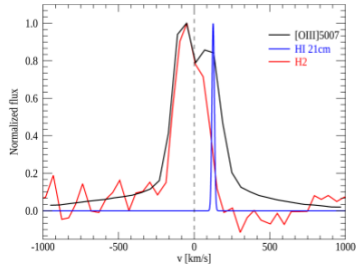


BPTで励起診断
✓ いずれの成分もAGN (or LINER)
➢ narrowは光電離、broadはshock
Broadについて
- [OIII]輝線比とHe II/Hβ⇒高い温度
- [FeII]/Paβ~1.4

➢ Shock励起



水素分子ガス・水素原子ガスの確認
✓ 水素分子輝線・21cm
➢ outflowの証拠は無い



Cold gas outflowの起源
✓ ジェットの年齢順に並べる
- 若いジェット⇒電離ガスのみ
- 中間的なジェット⇒電離ガス・coldガス
- 古いジェット⇒coldガスのみ

➢ ジェットに伴うshockでISMが加熱される
➢ Shockが通過した後に冷えて、原子・分子ガスになる