M87 seen at 230GHz

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East Asia VLBI workshop @Hokkaido Univ. (2015 July)
Motivations

- We want to see “BH-shadow”.
- We want to know “jet-launch” mechanism.
EHT detects synchrotron emission at the jet base of M87 @230GHz

The 230GHz emission region size is 40 μas.
The emission region size is ~6Rs! That is why theorists also get excited!

1 Rs -> 7µas (6*10^9M☉)
Fully SSA-thick one-zone ($\theta_{\text{FWHM}}=40\mu\text{as}, 1\text{Jy}$) leads to too large $L_{\text{poy}}$?!

If EHT region is fully SSA-thick, then $B\sim300$ G. In this case, Poynting power exceeds $L_{\text{jet}}$, max $\sim 5\times10^{44}$ erg/s. Something’s wrong.

$$L_{\text{poy}} = 1.5 \times 10^{47} \text{ erg s}^{-1}$$

$$\times \left( \frac{B_{\text{tot}}}{300 \text{ G}} \right)^2 \left( \frac{2R}{1.8 \times 10^{16} \text{ cm}} \right)^2.$$
Solution: Partially SSA-thick

- The idea of partial-SSA-thick region can avoid too-large-$L_{poy}$ problem because $B \propto v_{ssa}^5$.
- If BH mass is smaller, then BH-shadow may be hidden by the SSA-thick region.
ISCO give us the upper limit flux of the SSA-thick region

\[ \text{ISCO} = 3R_s = 21 \mu \text{as}, \ 0.27 \text{Jy} \]

Toy Model Prediction of corr. flux density
(simulation by Satomi Nakahara, under-grad work)

- Green: Gaussian w/ BH
- Blue: Ring w/ BH
- Red: Gaussian w/o BH
- Light Blue: Top-hat w/o BH
More realistic case for M87 will be presented by Akiyama-san!

I will also show you the importance of Nobeyama 45m!
Importance KaVA monitoring at 22/43GHz will be presented by Hada-san!

KaVA image of M87 at 43GHz (2015 May, C4-mode)

Data analysis by Niinuma

Cont peak flux = 6.4936E-01 JY/BEAM
Image rms = 0.8E-03 JY/BEAM

0.5mas = 70Rs
Summary

- The issues “BH-shadow” and “jet-launching” are tightly connected. SSA-thick ($B$-dominated) region @230GHz might partially hide “BH-shadow”.
  

- JVN/KVN-Hawaii baselines are essential for discriminating “BH-shadow” models @230GHz.
  
  Akiyama-san’s talk

- KaVA@22/43GHz is a strong tool to prove “jet-launching/acceleration” in the range 70 Rs – 1400 Rs.
  
  Hada-san’s talk
“Central Engine” and “BH-shadow” are inside! This is why theorists also get excited!
Allowed \( \log (U_{\pm}/U_B) \), \( B_{\text{tot}} \), \( \gamma_{\pm,\text{min}} \) in the SSA-thick region.

We find \( U_{\pm} \ll U_B \).