Early Phase Coverage of Extragalactic/Galactic Black Hole Transients
Exploration of Non-stationary accretion regime

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Two types of black hole transients are the focus:

Black Hole X-ray Binaries (BH XRBs) - Stellar mass black holes
Tidal Disruption Events (TDEs) - Supermassive black holes
Galactic Black Hole Transients - A brief introduction of their outbursts

- SKA is able to detect black hole binary transients in quiescence at the level of 1-30 uJy
- SKA is able to monitor the entire outbursts and establish the complete picture of the evolution of radio jet
- SKA is able to send out alerts to space and other ground observatories early enough for breakthrough discoveries
Variable X-ray Sky = variable radio sky!
for systems of a nature of BH accretion
X-ray Monitoring of BH transients: trigger follow-up radio observations

X-ray All Sky Monitoring

Follow-ups observations in radio

Radio observations (in blue):
- were delayed and sparse
- all after detections in X-rays
SKA - to change the history of monitoring BH transients

1. Wide FOV radio monitoring can be relatively much more sensitive!

**Sensitivity: X-ray vs. Radio**

**Radio - X-ray Correlation (Gallo et al. 2003)**

**Current X-ray Monitoring:**
- ~ a few mCrab per day
- ~ 10 mCrab per hour

Corresponding to:
- ~ 10 mJy in radio per hour

**Next generation X-ray monitoring**
- ~ only 100 times sensitive!
  - corresponding to 0.1 mJy per hour

Which is at least two orders of magnitude above than the SKA’s sensitivity!

SKA full can monitor BH XRB in quiescence: ~ 1-30 uJy

Inaccessible from X-ray ASM!
SKA - to change the history of monitoring BH transients

2. Wide FOV radio monitoring can cover outbursts at much earlier time!

X-ray monitoring of Soft X-ray Transient

Extrapolation of the rise back in time:
outburst started at least one or a few weeks before
This is within SKA’s sensitivity limit!

A week’s lead makes a lot difference

RXTE can respond to schedule observations in a day’s time, but was still not able to cover the early rising phase

Tuesday, June 10, 14
- A star is disrupted by the supermassive black hole in the center of galaxies

- allows us to probe the mass and spin of the SMBHs in the centers of galaxies, which compose about 90% of SMBHs in the cosmos
Tidal Disruption Flares:
- The rise is not well known

- Covers an extremely large range of mass accretion rate:
  \( \sim 10^{35} \text{ ergs/s} - 10^{47} \text{ ergs/s} \)

- Little is known about the rising phase (theory and observation aspects)
  - the start of the flare would occur weeks before its peak

- The large FOV and high sensitivity of SKA allows detection of how it starts
SKA - powerful machine to detect TDE flare in the rising

1. Wide FOV radio monitoring is more sensitive than X-ray monitoring!

Radio facilities are more effective than X-ray facilities towards lower luminosity
SKA - the first to make discoveries & sending out alerts

2. Wide FOV radio monitoring can tell us about the rising phase and early enough to alerts space observatories and other ground facilities

Early detection and coverage of the very rising phase of TDE flare is very important and will make difference (using XMM-Newton early enough would get BH mass and spin measurement !)
Accretion Physics in the Extreme Regimes

- Extremely large rate-of-increase of the mass accretion rate (usually go with relativistic jets seen in microquasars)

E-folding rise time scales
- BH and NS soft X-ray transients
  \[ L \sim 10^{31-39} \text{ ergs/s in 50 days} \sim 3 \text{ days} \]
- Tidal disruption flares
  \[ L \sim 10^{34-46} \text{ ergs/s in <50 days} \sim 0.3 \text{ days} \]

SKA’s large FOV and high sensitivity makes it among the best facility to probe disk-jet physics under extreme rate-of-increase of Mdot
SKA’s campaigns on extragalactic and Galactic X-ray Transients

Galactic Bulge radio monitoring on a daily basis

- **SKA1-survey and SKA1-low:**
  30 short observations to cover 25x25 square degrees Bulge region and down to 0.01 mJy allows SKA1 to detect transient outbursts a few days before detections with X-ray monitors

- **SKA-full**
  3 short observations to cover 25x25 square degrees of the Bulge region allows SKA-full to detect transient outbursts a week before detections with X-ray monitors

Extragalactic TDE transients

- **SKA-full**
  Dedicated to certain FOV of interest (e.g. Virgo cluster) would be helpful allows SKA-full to detect TDE flares a week before detections with any future X-ray monitors
SKA will be able to change the history of monitoring black hole transients - radio monitoring will lead ...

SKA will open a new window on time domain studies
- coverage of the rising phase & exploration of the non-stationary accretion-jet regimes

SKA will take a leading role on detections of black hole transients
- to follow or to be followed