A Massive Outburst in NGC 660

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What have we found?

• There is a massive outburst in the center of the nearby galaxy, NGC 660 (44 M light years)
• This is probably caused by material falling onto the central black hole
• It was found serendipitously with the 305-m (1000 ft) telescope at Arecibo Observatory during a survey for molecular lines
• Catching such an outburst starting is very rare, if not unique

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What we saw in the survey spectra

DEc 2007

- We were carrying out a survey of 19 galaxies where we thought we might find molecular lines
What we saw in the survey spectra

**DEC 2008**

- We were carrying out a survey of 19 galaxies where we thought we might find molecular lines
- By chance, this meant we were watching when the outburst began – so we kept watching
What we saw in the survey spectra

DEC 2010

• We were carrying out a survey of 19 galaxies where we thought we might find molecular lines
• By chance, this meant we were watching when the outburst began – so we kept watching
What we saw in the survey spectra

**DEC 2011**

- We were carrying out a survey of 19 galaxies where we thought we might find molecular lines
- By chance, this meant we were watching when the outburst began – so we kept watching
- To get high-resolution images, we used the High Sensitivity Array (HSA)

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Telescopes of the HSA

Arecibo 305-m Telescope

100-m Green Bank Telescope (GBT)

Effelsberg Radio Telescope

Very Long Baseline Array (VLBA)

Arecibo: Image courtesy of the NAIC – Arecibo Observatory, a facility of the NSF. GBT: Image courtesy of NRAO/AUI. Effelsberg: Image courtesy of Max Planck Institute for Radio Astronomy. VLBA: Image courtesy of NRAO/AUI and Earth image courtesy of the SeaWiFS Project NASA/GSFC and ORBIMAGE.

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What did we expect to see?

- A ring – evidence for a supernova origin
- This would be by far the brightest supernova seen in the radio

- A jet – evidence for an origin in material falling onto the central black hole

Images courtesy of NRAO/AUI.

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What did we see?

HSA image of bright "hotspots" (inset), in galaxy NGC 660. Entire HSA image is less than a pixel in the larger optical image.

Image credit: Minchin et al., NRAO/AUI/NSF (HSA); Travis Rector, Gemini Observatory, AURA (optical).
How do we explain this?

Rather than a single jet with a core and two hotspots, we see five bright spots.

We think the black hole is precessing – wobbling like a spinning top.

This means that we see a cone shape with a pair of bright spots at their ends, where we are looking through the side of the cone.

*Image credit: Minchin et al., NRAO/AUI/NSF.*

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What are we doing next?

• We are continuing to monitor NGC 660 with Arecibo

• We will be applying for more time with the HSA to see if we can see the ‘hotspots’ on the ends of the cones moving outwards
  – If we see this, it will confirm our interpretation
  – If not, then we will have to think again
Further Information

• Press Release:
  http://www.nrao.edu/pr/2013/ngc660/
• This presentation:
  http://www.naic.edu/~rminchin/ngc660.pdf
• Email: rminchin@naic.edu
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