Update on the JVLA-Chandra Orion Project

Scott Wolk for Jan Forbrich
The radio-X-ray connection

Güdel (2002)
Forbrich & Wolk (2013)
The essence of the VLA (and VLBA) **upgrade**
The Orion Radio All-Stars: a new deep centimeter radio look at the Orion Nebula Cluster

- 30h of VLA C-band data in a single pointing toward the ONC, in the A configuration, with simultaneous Chandra observations. Increased the number of known radio sources by 7x. First systematic time domain data set for YSOs.

- 30h of VLA C-band observations in surrounding fields, with simultaneous Chandra and NuStAR observations.

- 4+ epochs of astrometric VLBA follow-up of all 556 VLA sources
The Orion Radio All-Stars: a new deep centimeter radio look at the Orion Nebula Cluster

- **New technical challenges** in interferometric imaging
- Wideband receivers and their vastly increased continuum sensitivity, combined with in-band spectral indices, come at the price of a much more complex primary beam to be accounted for.
- Entering the time domain is tricky when your main imaging algorithms (like CLEAN) assume a constant sky. Not accounting for variability has an impact on imaging dynamic range, both in VLA and ALMA data.
- In both areas, new algorithms are in development, but they are (of course…) compute-intensive.
This is a VLA image of the Trapezium and the main proplyds! with and additional spatial filtering (100 k\(\lambda\)).

Forbrich et al. (2016)
This is a VLA image of the Trapezium and the main proplyds!

Forbrich et al. (2016); Forbrich, O'Dell, et al., in prep.
This is an HST image of the Trapezium and the main proplyds!

Forbrich et al. (2016); Forbrich, O'Dell, et al., in prep.
The radio-X-ray-infrared population

Forbrich et al. (2016)
Exploring YSOs in the radio \textit{time domain}
Exploring YSOs in the radio – X-ray time domain

Forbrich et al. (2017)
Status ....

• Detected 556 radio sources in 30 hours of JVLA pointed at the ONC.
• Spectral types O-M
• This is similar to the number of X-ray and IR sources in the field but the overlap is 1/3, 1/3, 1/3.
• 13 show extreme radio variability some on timescales < 1 hour which appear accompanied by X-ray flares
• On the other hand 5 of the extreme radio variables have no X-ray variability
• All extreme radio variables are X-ray sources.
... next steps

- Analyze the relationship between the radio and optical proplyds.
- We have now followed up all 556 VLA detections with the VLBA, a [data record](#) for the VLBA (Forbrich et al., *in prep.*).
- Relate the spectral indices to the objects
- Finish analysis of 2016 Program: wider field and simultaneous NuStar and Chandra data looking for hard flares.
- Actually look at the GB relation for these stars.