The Transient survey:
Detection of sub-mm variability in a Class I protostar EC 53 and the preliminary result of 450 μm data analysis

Luminosity problem

* Shu’s model on gravitational collapse
  : young star grows from infalling envelope at steady rate $\sim 2 \times 10^{-6} \, M_\odot \, \text{yr}^{-1}$

* Kenyon et al. (1990)
  : luminosity of most protostars are far below than expected with steady accretion over protostellar lifetime ("Luminosity problem")
  : rapid accretion could occur in a series of very short burst with high accretion rate ("Episodic accretion")

Dunham+10
* The aim of the project
  : episodic accretion is one solution of the luminosity problem
  : monitoring YSOs in 8 star forming regions to detect submm variability
    (monthly observation for 3.5+ years)

* Scientific merit
  : first ground-based program dedicated to surveying protostellar
    variability in submm wavelength to spend years
  : wide field-of-view (30 arcmin)
  : factor of 2.5 deeper than JCMT Gould Belt Survey
Serpens Main

Yoo et al. (2017)
Fractional uncertainty = standard deviation over 11 epochs / mean flux

Coincidence with a protostar (EC 53)
* EC53 (V371 Ser)
- Class I source
- variable in K-band
- strong indication of periodicity from ~ 20 yrs monitoring (P ~ 543 days)
- multiplicity
Sub-mm variability of EC 53

* The first protostellar variable source observed from JCMT Transient 850 μm data

Similarity of light curve between K-band and sub-mm (850 μm)

**Periodic** light curve (period of ~543 days; Hodapp et al. 2012)

flux increase at 850 μm ~ factor of 1.3 (expected maximum ~ factor of 1.5)
Spectral energy distribution

* Simple model for observed spectral energy distribution (SED) of EC 53

A flux enhancement by a factor of $\sim 1.5$ at 850 $\mu$m

- An increase of the central luminosity by a factor of $\sim 4$
- An increase of the envelope temperature by a factor of $\sim 1.3$
- Accretion burst change the temperature profile and spectral energy distribution at all wavelength

- The flux variation in the SED at shorter wavelengths is more sensitive to the change of luminosity of the central protostar

Johnstone et al. 2013
JCMT atmospheric transmission

* The dependence of atmospheric transparency variation on opacity and wavelength

The 450 \( \mu m \) atmospheric window (severely affected by water vapor) requires much drier condition or long integration time.

Less stable beam profile at 450 \( \mu m \) than 850 \( \mu m \)

< Measured beam of Uranus >

Holland et al. 2013
Signal-to-noise ratio maps

- significantly lower signal-to-noise ratio at 450 μm
- 450 μm maps need careful flux calibration
Transient survey + Complementary observations

* Series of high-sensitivity observations of Serpens Main using JCMT/SCUBA-2

- **M17BP054** (declining phase) ; done
- **M18AP017** (min. to max. phase) ; soon
  (PI : Hyunju Yoo)

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22 Epochs from Transient survey
+ 5 Epochs from M17BP054
Preliminary results

- Replicated K-band
- $\Delta K$-mag : 1.5 ~ 2
Summary

* JCMT Transient survey aims to detect the evidence of episodic accretion from the monthly monitoring observation in sub-mm.

* We detect a new sub-mm variable source EC 53, which has been reported as a variable source in K-band with periodicity (period ~ 543 day). There is strong resemblance between light curves in K-band and 850 micron.

* We expect the increase of accretion luminosity by factor of 5.3 from simple SED model assuming flux increase by factor of 1.5 at 850 micron.

* JCMT/SCUBA-2 450 μm map shows low S/N ratio and relatively unstable beam profile than 850 μm map and the relative flux calibration is difficult due to high level of rms noise.