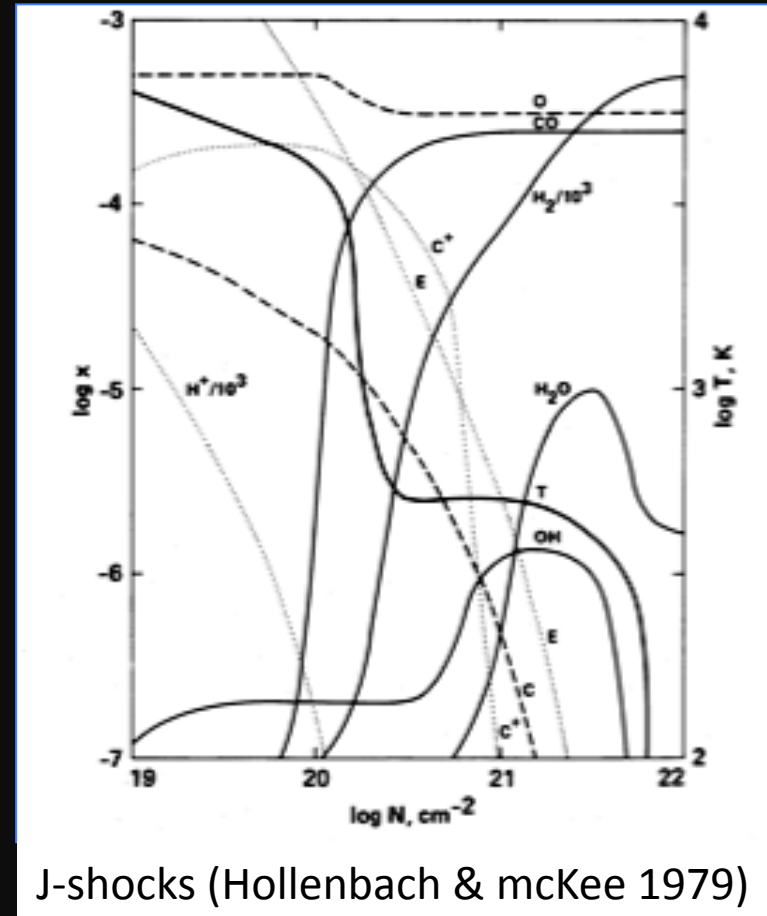
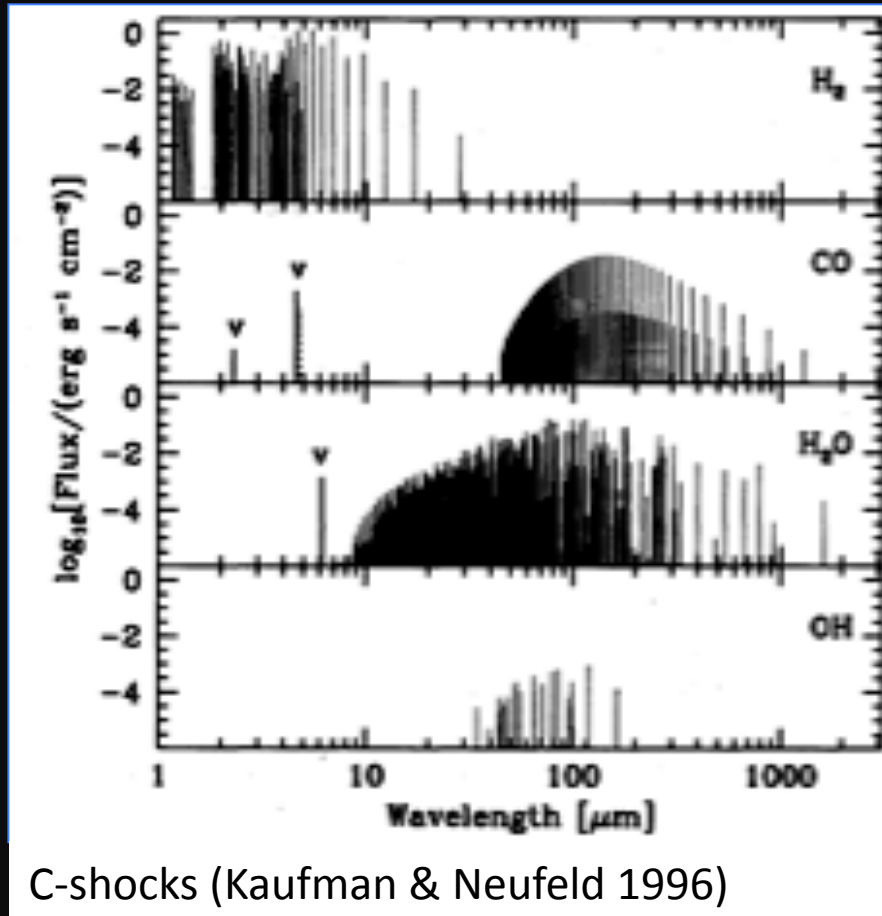


# THE OUTFLOW

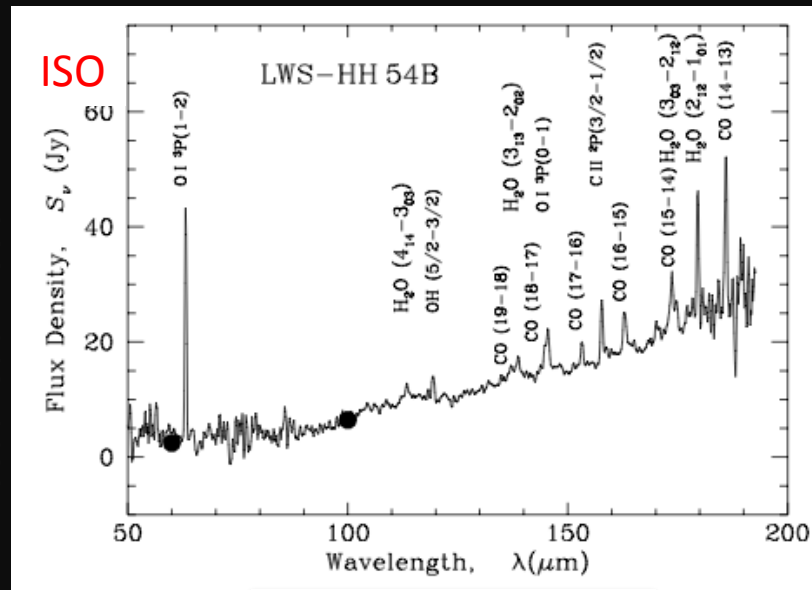
## MOLECULAR SHOCKS: EXPECTED WATER FUNTAINS



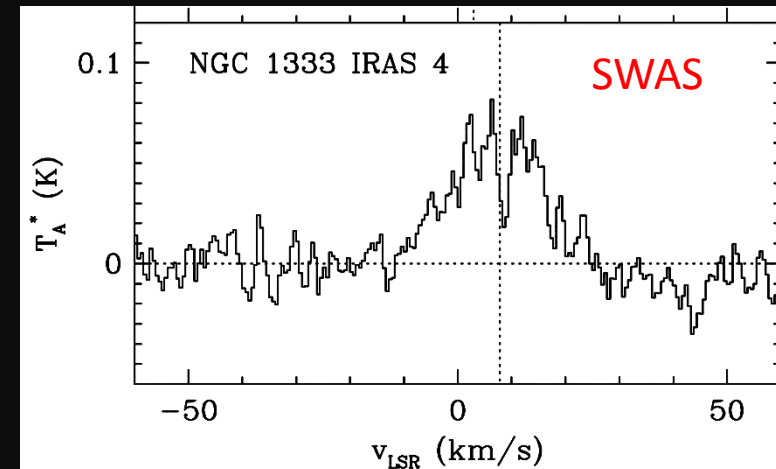
# THE OUTFLOW

OBSERVATIONS OF WATER IN MOLECULAR OUTFLOWS OBTAINED WITH ISO (many lines, poor spectral resolution  $\approx 200$ ), SWAS AND ODIN (fundamental o-H<sub>2</sub>O line @557GHz, high spectral resolution  $\approx 10^6$ , poor spatial resolution  $\approx 1.5-4'$ )

Liseau et al. 1996



$$x(\text{H}_2\text{O}) \approx 10^{-5}$$



$$x(\text{o-H}_2\text{O}) \approx 10^{-7}-10^{-5}$$

Bergin et al. 2003

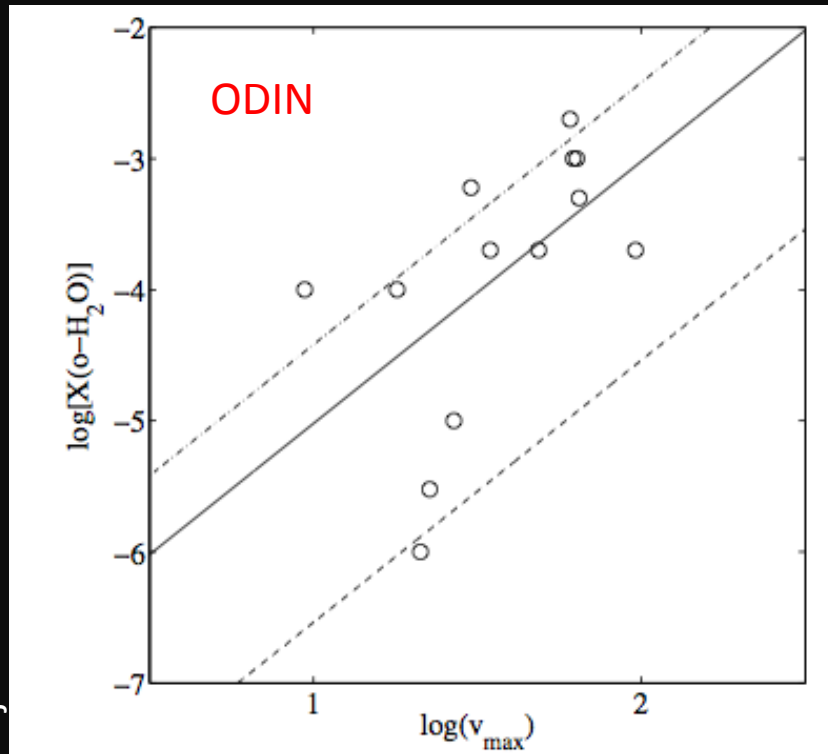
YES, WATER IS ABUNDANT INDEED...**BUT NOT SO MUCH AS EXPECTED**

# THE OUTFLOW

YES, WATER IS ABUNDANT INDEED...

**BUT NOT SO MUCH AS EXPECTED**

(ISO: Nisini et al. 2002, SWAS: Franklin et 2008, ODIN: Bjerkerli et al. 2009...)

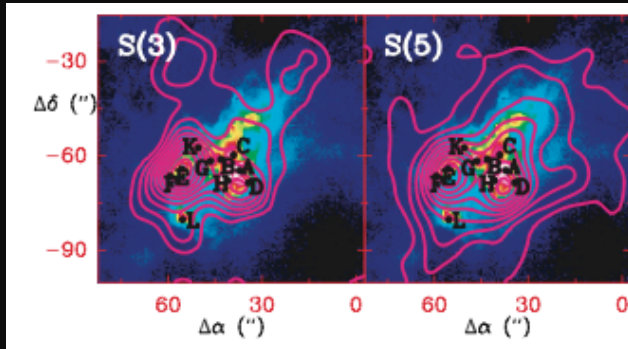


Bjerkerli et al. 2009

THE WATER ABUNDANCE INCREASES WITH THE GAS TEMPERATURE/MAX VELOCITY in rough agreement with predictions for non-dissociative C-shocks

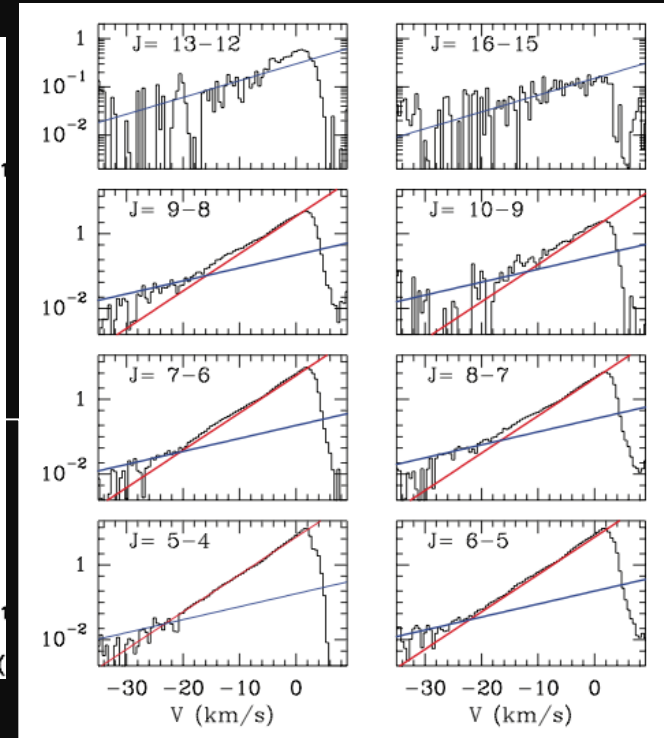
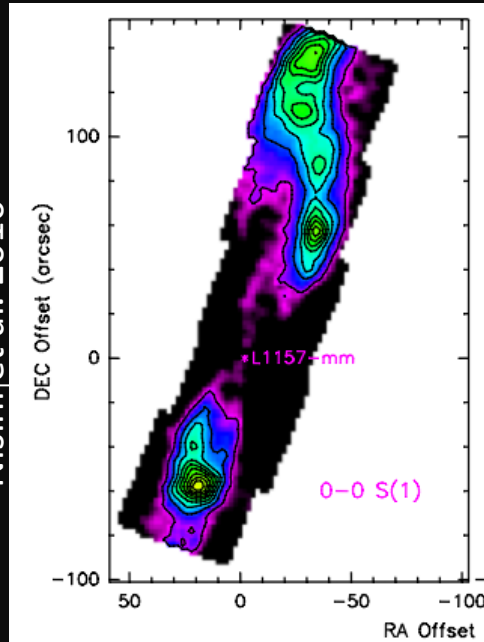
# THE OUTFLOW

HOW MANY COMPONENTS? HOW MANY SHOCKS?



Lefloch et al. 2003

Nisini et al. 2010



Lefloch et al. 2012

H<sub>2</sub> AND H<sub>2</sub>O EMISSION OBSERVED BY ISO/SPITZER/AKARI+HERSCHEL TESTIFIES OF NON DISSOCIATIVE SHOCKS WHILE OI EMISSION OBSERVED BY KAO/ISO TESTIFIES OF DISSOCIATIVE SHOCKS

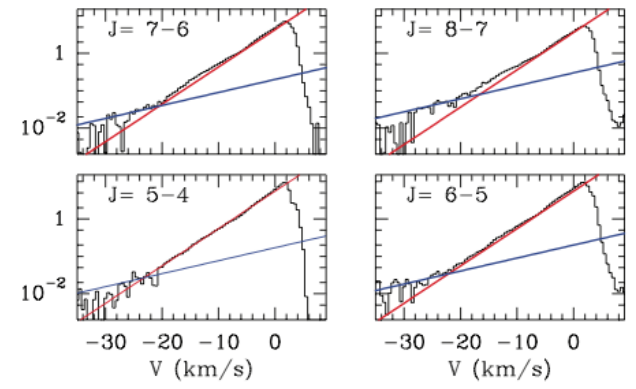
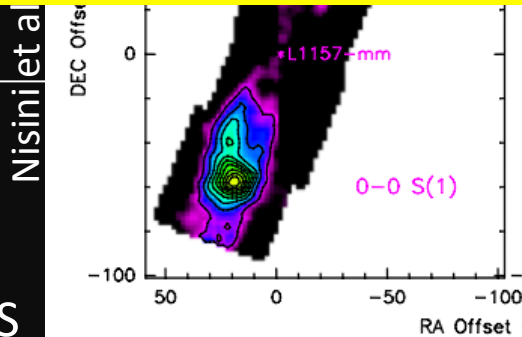
NEW HIFI-HERSCHEL OBSERVATIONS SHOW THE PRESENCE OF 3 COMPONENTS, WHOSE RELATIVE CONTRIBUTION CHANGES WITH THE ENERGY OF THE TRANSITION

# THE OUTFLOW

HOW MANY COMPONENTS? HOW MANY SHOCKS?

**SPICA WILL PROVIDE A HUGLY LARGER SET OF DATA FOR MAPS OF WARM GAS IN MOLECULAR SHOCKS HELPING IN UNDERSTANDING THE FEEDBACK OF STAR FORMATION**

H<sub>2</sub> AND H<sub>2</sub>O EMISSION OBSERVED BY ISO/SPITZER/AKARI+HERSCHEL TESTIFIES OF NON DISSOCIATIVE SHOCKS WHILE OI EMISSION OBSERVED BY KAO/ISO TESTIFIES OF DISSOCIATIVE SHOCKS



Lefloch et al.2012

NEW HIFI-HERSCHEL OBSERVATIONS SHOW THE PRESENCE OF 3 COMPONENTS, WHOSE RELATIVE CONTRIBUTION CHANGES WITH THE ENERGY OF THE TRANSITION

More in Nisini's talk

# CONCLUSIONS

HERSCHEL IS HELPING TO SOLVE THE SEVERAL OPEN QUESTIONS LEFT BY ITS PRECEDESSORS AND MORE WILL COME IN THE COMING YEARS, BUT IT WILL NOT ANSWER **ALL** QUESTIONS: SPICA WILL BE GREATLY IMPROVE OUR UNDERSTANDING OF

1. The census
2. The structure
3. The chemistry
4. The outflow

