

MAGNETIC FIELDS INSIDE-OUT

UNVEILING MAGNETIC FIELDS IN MASSIVE PROTOSTARS



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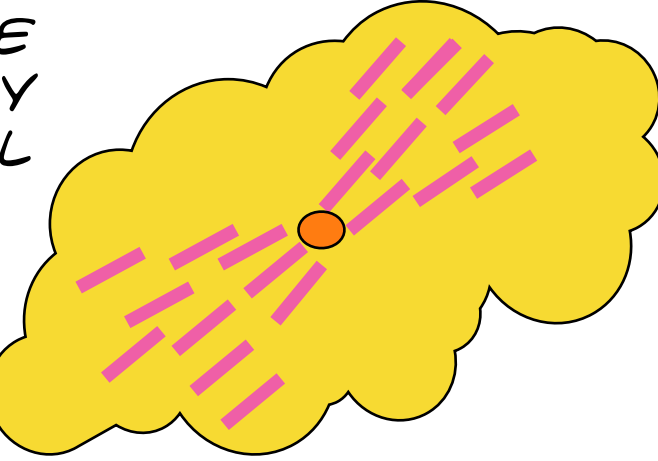
BACKGROUND

IT IS STILL UNCLEAR HOW MAGNETIC FIELDS INFLUENCE HIGH-MASS STAR FORMATION.

MAGNETIC FIELD LINES PERMEATE THE ISM AND THE GIANT MOLECULAR CLOUDS.

IN A MAGNETICALLY REGULATED COLLAPSE, THE FIELD LINES ARE DRAGGED BY THE INFALLING MATERIAL...

WHILE SOME WORKS HAVE OBSERVED CONSISTENCY WITH THIS THEORETICAL MODEL...



...OTHER STUDIES SHOWED EVIDENCE OF MORE CHAOTIC MAGNETIC FIELD MORPHOLOGIES.

HOW DO MAGNETIC FIELDS AFFECT THE FRAGMENTATION OF THE MOLECULAR CLOUD, THE COLLAPSE OF THE CORE AND THE FORMATION OF DISCS AND JETS?

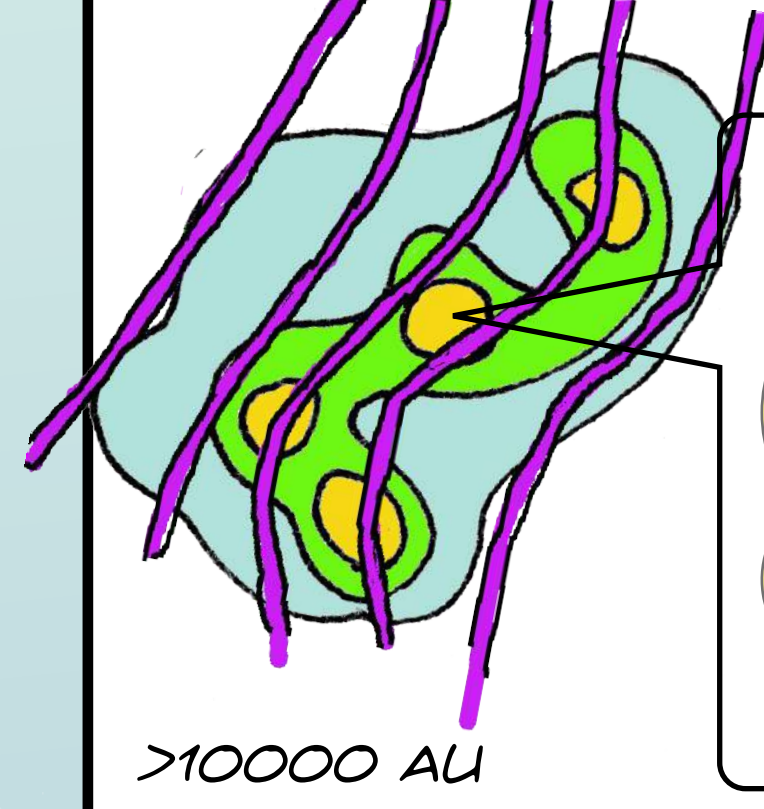
ARE MAGNETIC FIELDS DYNAMICALLY IMPORTANT WITH RESPECT TO GRAVITY AND TURBULENCE?

A POSSIBLE WAY TO ANSWER THESE QUESTIONS IS TO INVESTIGATE SEVERAL SPATIAL SCALES...

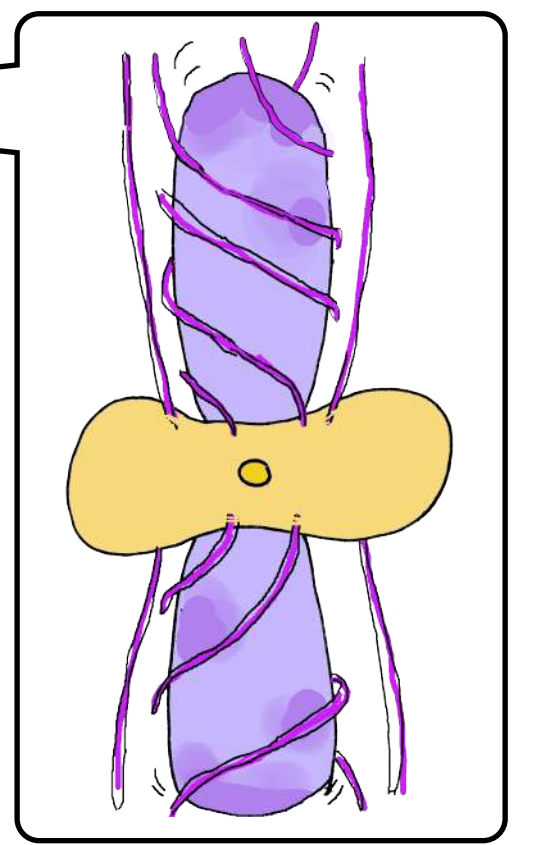
-- FROM CLOUD --

-- TO CORE --

-- TO JET/DISC --



10000-1000 AU



1000-100 AU

...AND OBSERVE CLEAR SIGNATURES OF A MAGNETICALLY REGULATED COLLAPSE, AT DIFFERENT WAVELENGTHS AND USING DIFFERENT TRACERS.

METHODS

MASER POLARISATION TRACES THE MAGNETIC FIELD AT THE DISC/JET SCALE.

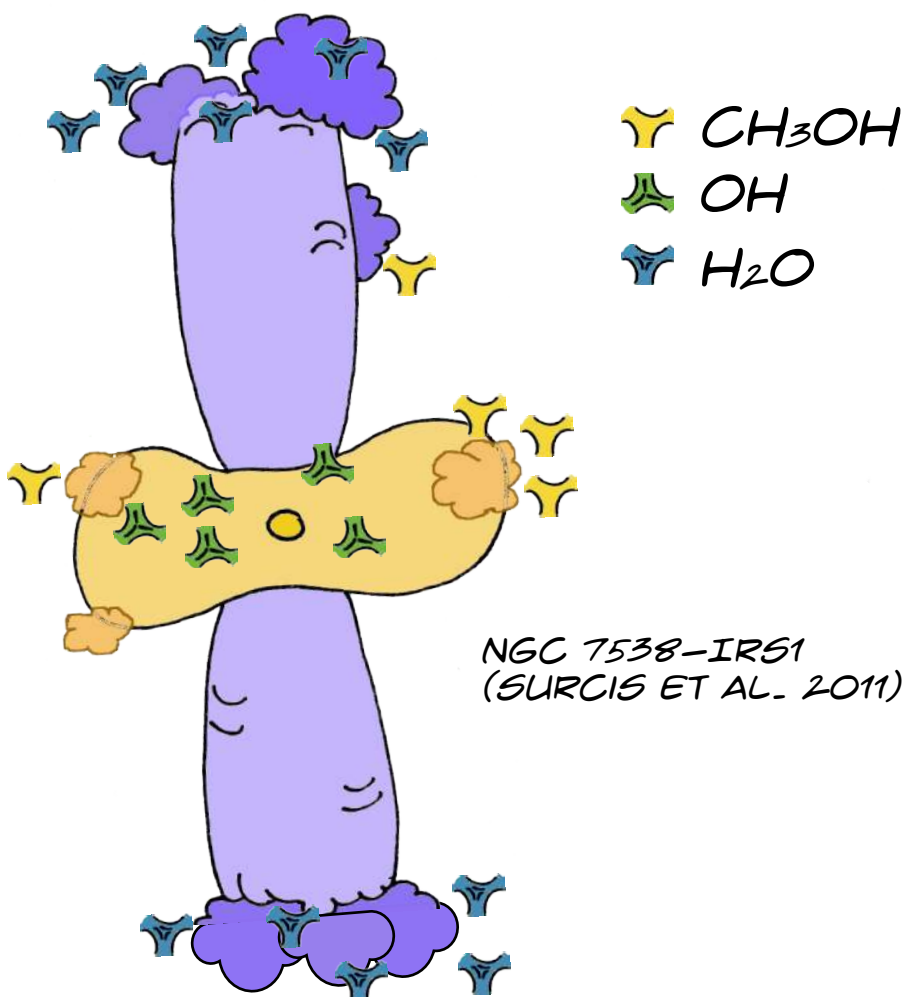
DUST POLARISATION GIVES AN OVERVIEW OF THE MAGNETIC FIELD AT THE CORE AND CLOUD SCALE.

THERMAL LINE POLARISATION (GOLDREICH-KYLAFIS EFFECT) ALLOWS A 3D SCAN OF THE MAGNETIC FIELD.

WE SELECT HIGH-MASS PROTOSTARS, SPANNING DIFFERENT LUMINOSITIES AND MASSES.

WE OBSERVE THEM AT SEVERAL WAVELENGTHS AND SCALES.

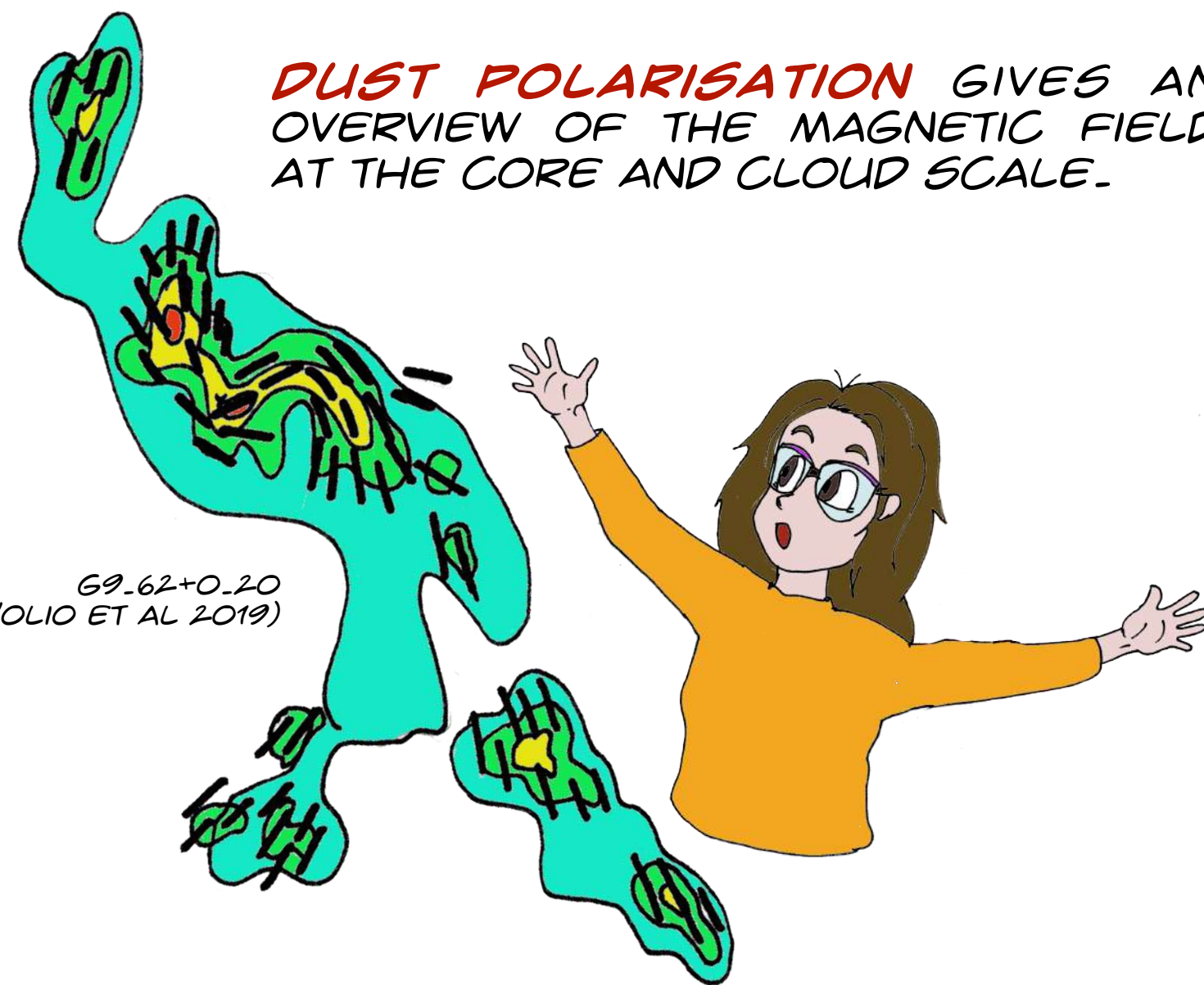
WE COMPARE MAGNETIC FIELD ESTIMATES OBTAINED WITH DIFFERENT TRACERS.



NSC 7538-IRS1 (SUGRIS ET AL. 2011)

BY DETECTING CIRCULAR POLARISATION (ZEEMAN SPLITTING), WE MEASURE THE MAGNETIC FIELD STRENGTH.

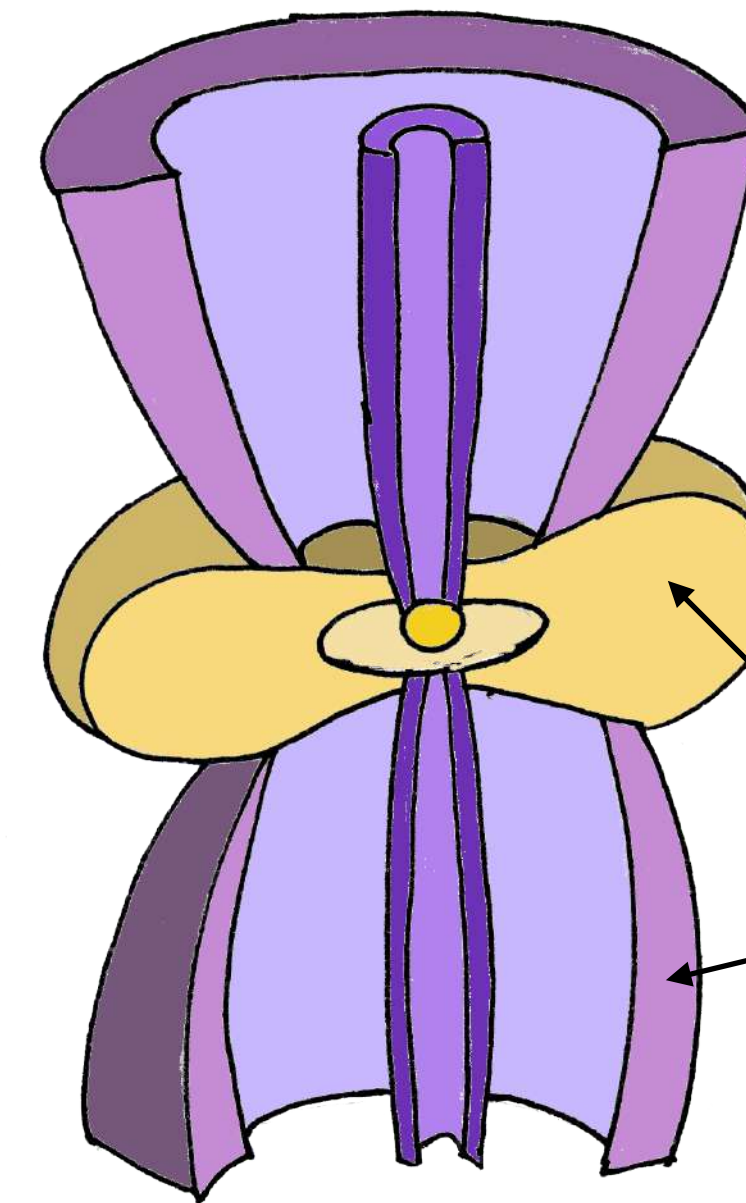
(REVIEW BY CRUTCHER & KEMBALL 2019)



G9.62+0.20 (DALL'OLIO ET AL. 2019)

BY APPLYING DAVIS-CHANDRASEKHAR-FERMII METHOD OR THE STRUCTURE FUNCTION, WE INFER THE MAGNETIC FIELD STRENGTH.

(REVIEW BY HULL & ZHANG 2019)



EACH MOLECULAR LINE IS EMITTED BY A KNOWN LAYER OF THE PROTOSTAR.

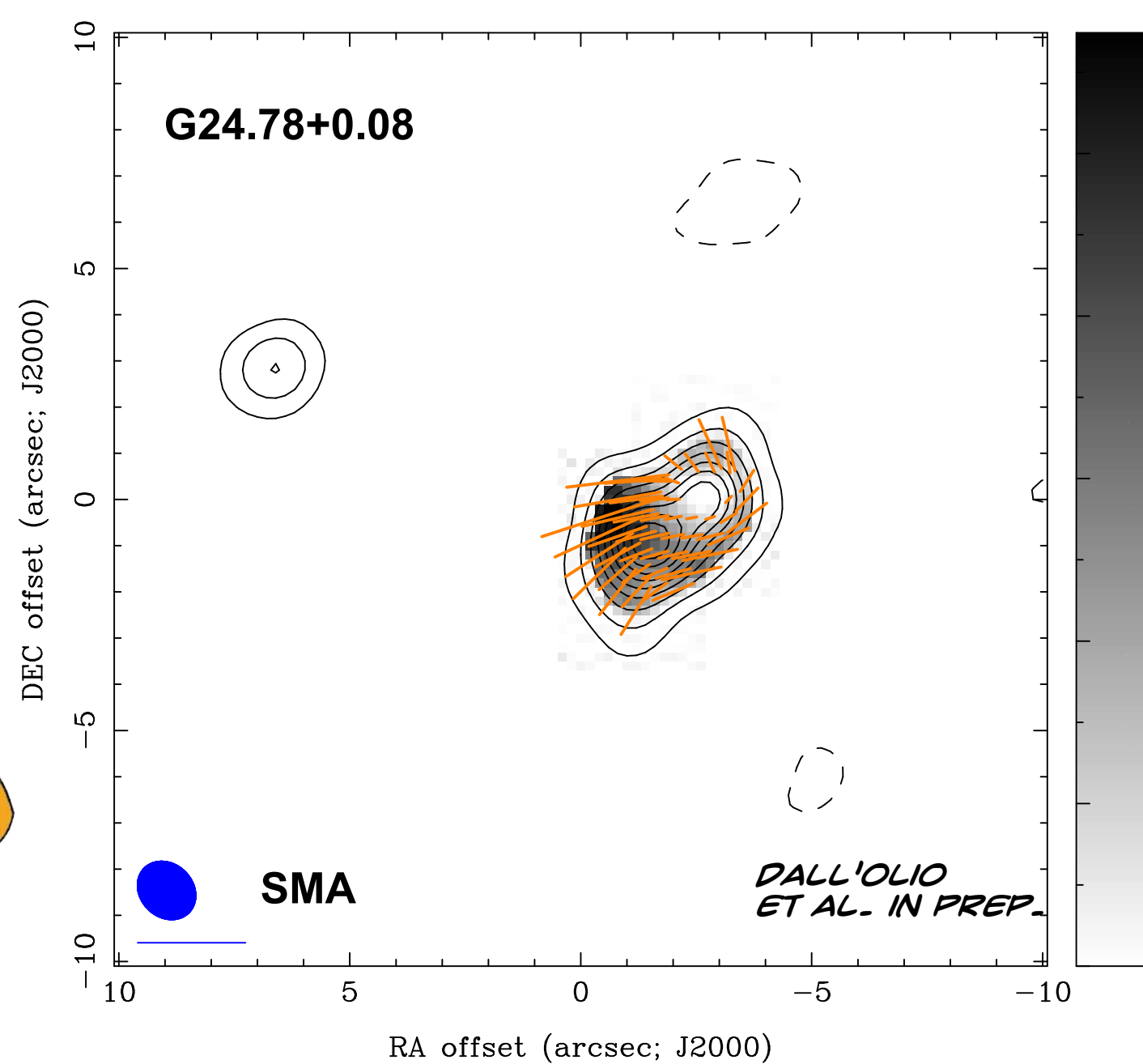
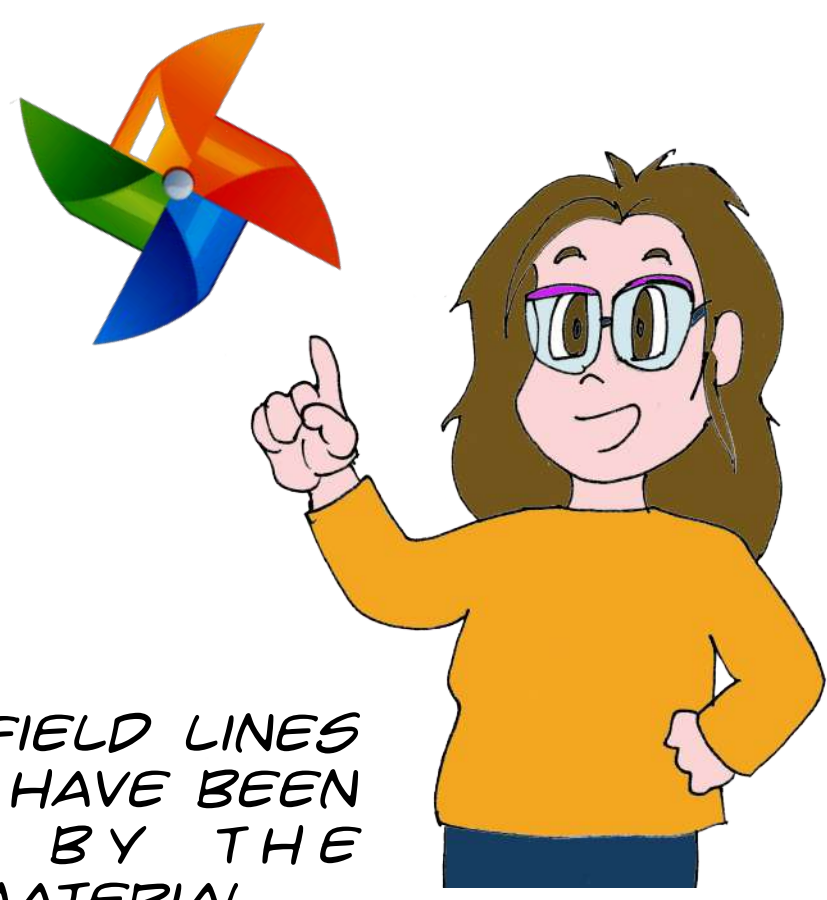
WE USE THE "PORTAL" CODE TO MODEL THE POLARISATION RESPONSE FROM EACH MOLECULE AND PRODUCE MAGNETIC FIELD MAPS.

LANKHAAR ET AL. 2020

RESULTS

PINWHEEL MORPHOLOGY OF THE MAGNETIC FIELD AT THE CORE SCALE IN G24.78+0.08

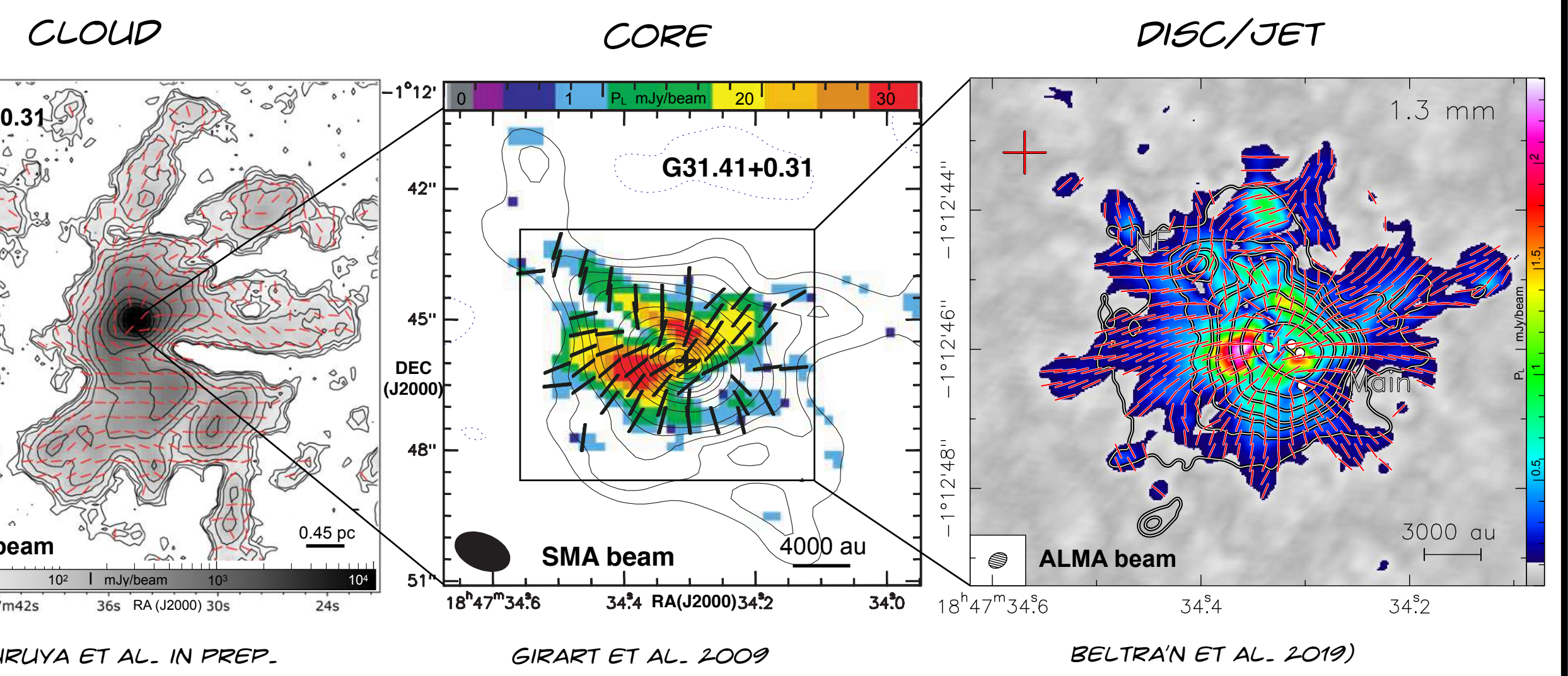
MAGNETIC FIELD LINES APPEAR TO HAVE BEEN TWISTED BY THE INFALLING MATERIAL.



HIGHER RESOLUTION OBSERVATIONS WITH ALMA ARE NEEDED TO CONFIRM THE SPIRAL MORPHOLOGY AT SMALLER SCALES.

RESULTS

MULTI-SCALE HOURGLASS MORPHOLOGY OF THE MAGNETIC FIELD IN G31.41+0.31

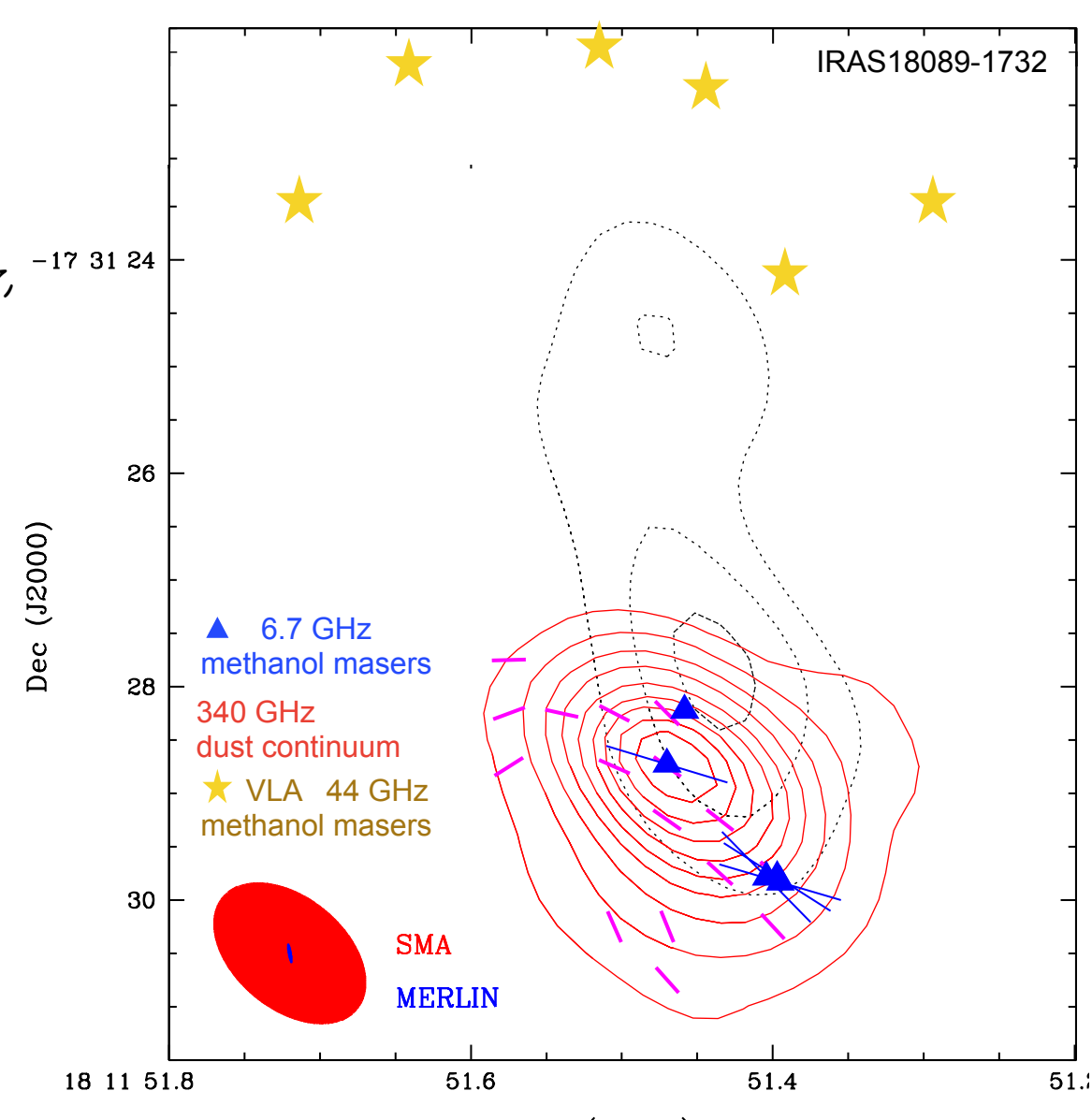


THE PINCHED MAGNETIC FIELD MAINTAINS ITS SHAPE AT DIFFERENT SPATIAL SCALES AND RESOLUTIONS.

SOON

VLA OBSERVATIONS OF 44 GHz METHANOL MASERS

DALL'OLIO ET AL. 2017, 2020, AND IN PREP.



WE WILL COMPARE MAGNETIC FIELD PARAMETERS BETWEEN DIFFERENT TRACERS IN SEVERAL SOURCES.

CONCLUSIONS

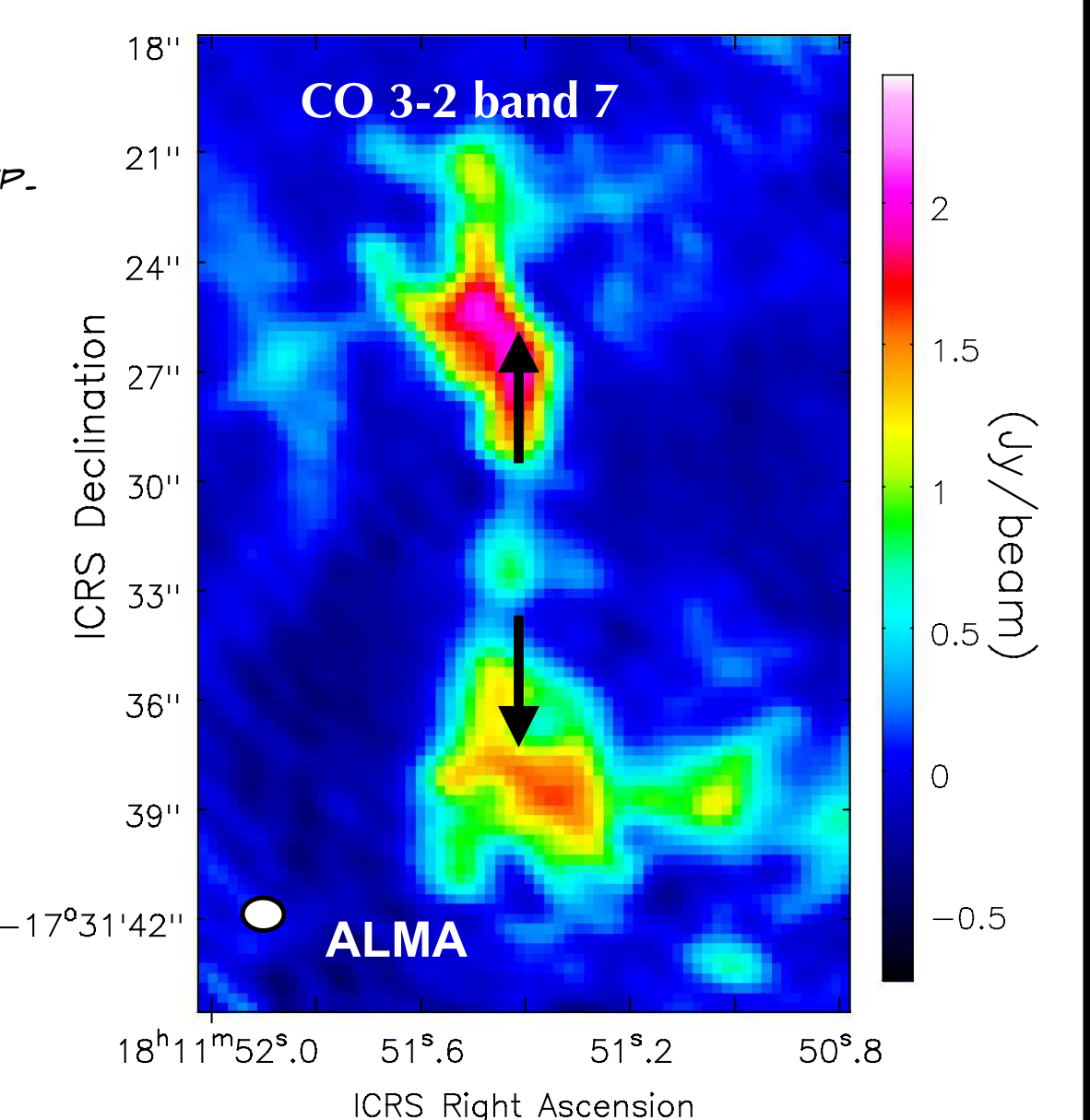
* A MULTI-WAVELENGTH AND MULTI-SCALE ANALYSIS PRODUCES THE MOST COMPLETE VIEW OF THE MAGNETIC FIELD IN A TARGETED PROTOSTAR.

* MULTI-TRACER OBSERVATIONS VERIFY THE CONSISTENCY OF THE MAGNETIC FIELD ORIENTATION ACROSS MULTIPLE SPATIAL SCALES AND WAVELENGTHS, INCREASING THE RELIABILITY OF THE RESULTS.

SOON

THERMAL LINE POLARISATION ANALYSIS OF IRAS18089-1732

DALL'OLIO ET AL. IN PREP.



PRELIMINARY RESULTS: THE MAGNETIC FIELD OF THE CO (3-2) OUTFLOW IS PERPENDICULAR TO THE TORUS.

