Astrophysics and Astronomy in Vietnam

P.N. Diep
Department of Astrophysics (DAP)
Vietnam National Space Center (VNSC)

WINDOWS ON THE UNIVERSE
6-12 Aug 2023, ICISE, Quy Nhon, Vietnam

Royal Office of Astronomy

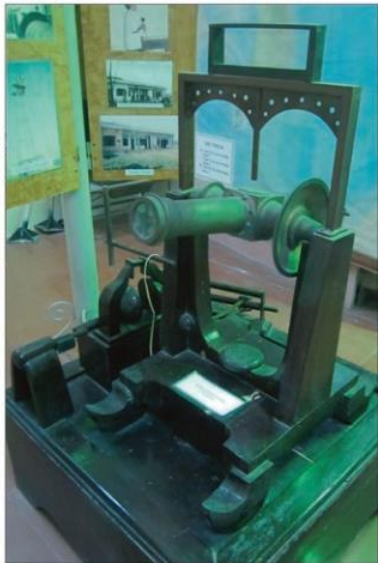
Responsible for making calendar, keeping time, predicting eclipses, …

Quan Tượng Đài

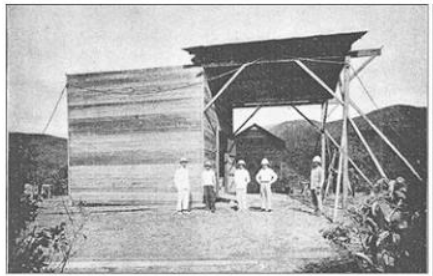
Bamboo stick calendar

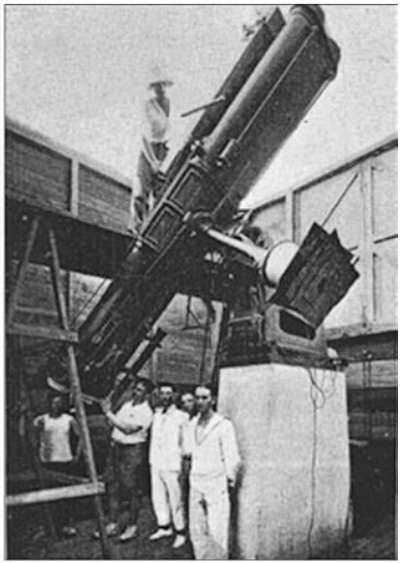
P.V. Loc & L.T. Lan, *A Brief History of Vietnamese Astronomy and Calendars During the Reign of the Royal Dynasties*, Chapter 3, Jul 2021

During the French colonial rule (i.e. before 1945)



Central Indochina Observatory





The French observing station at Poulo Condor (now Côn Sơn island) for the 9 May, 1929 total solar eclipse

P.V. Loc & L.T. Lan, *A Brief History of Vietnamese Astronomy and Calendars During the Reign of the Royal Dynasties*, Chapter 3, Jul 2021

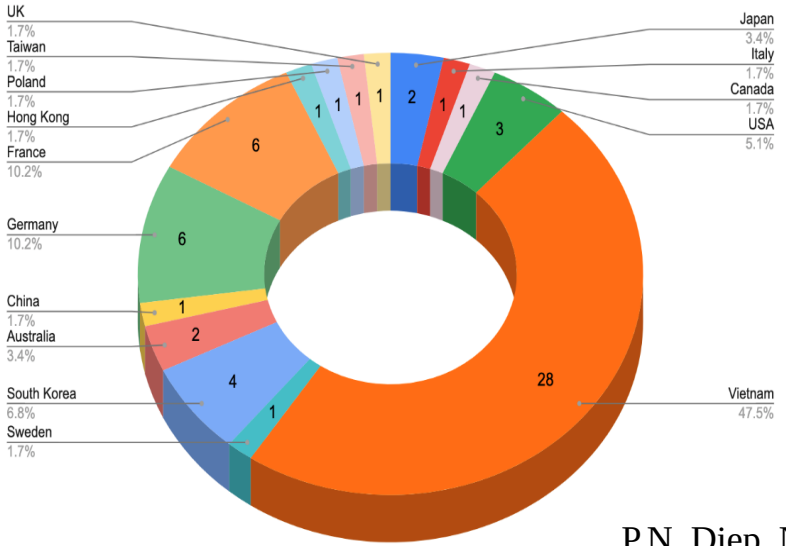
ASTROPHYSICS RESEARCH IN VIETNAM

Essentially limited to: Pr. Phan Bao Ngoc, IU (HCM city), Pr. Dinh Van Trung, IOP (Hanoi), Pr. Dao Tien Khoa, INST/Vinatom (Hanoi), Do Quoc Tuan, Phenikaa (Hanoi), VNSC/VAST Department of Astrophysics (6 PhD+2 PhD students) (Hanoi).

Most of us are working on radio astronomy: brown dwarf (Ngoc), molecular complexity around evolved stars (Trung), nuclear astrophysics (Khoa), cosmology (Tuan), high-redshift galaxies and stellar physics (DAP).

We use data obtained from collaborations or archival data.

IAU members	
Vietnam	14 Member status (Suspended)
Thai Lan	51
Malaysia	21
Indonesia	19
Phillipinnes	5

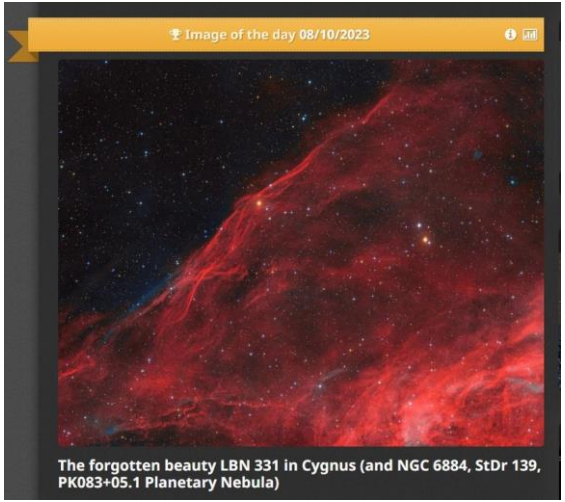


P.N. Diep, NatAst (2021)

OUTREACH

Several amateur astronomer clubs
Planetariums and similar initiatives at various places,
Hoa Lac, Quy Nhon, Nha Trang,…

Good introduction to astronomy/astrophysics given to space science students at University of Science and Technology of Hanoi (USTH) and future high school teachers in universities of education in HCM city and Hanoi



Two science exploration centres in Quy Nhon and Hanoi

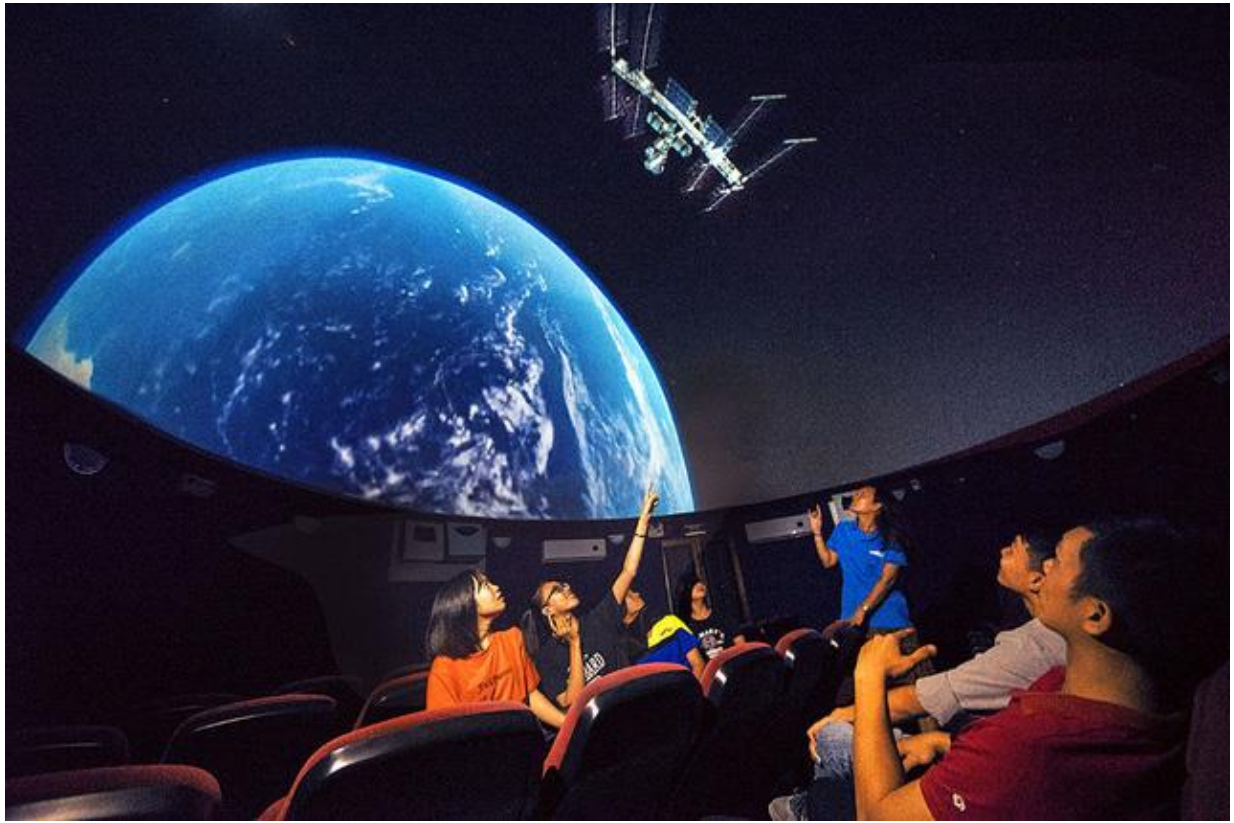
Quy Nhon completed in 2018

Hoa Lac to be completed in 2024

Completion of Nha Trang and Hoa Lac Observatories in 2018

VNSC is heading the Vietnam Space Center project. The headquarter is being built in Hoa Lac High-Tech Park (30 km, west of Hanoi).
It includes two observatories equiped with two planetariums (60 and 100 seats) and two 0.5 m optical telescopes, aimed at fostering interest on astronomy in the country and at helping with the training of students.

60-seat planetarium at Nha Trang Observatory



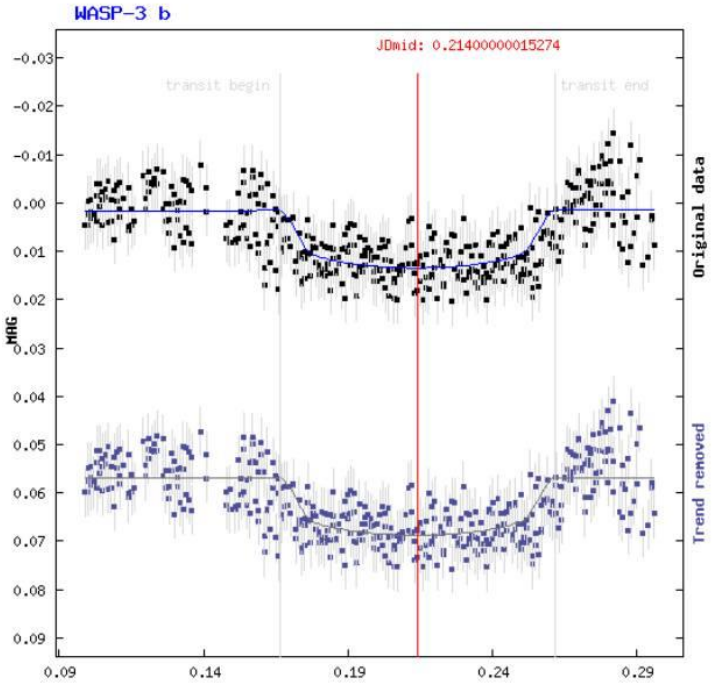
0.5 m optical telescope at Nha Trang Observatory

International Center for Interdisciplinary Science and Education (ICISE)

The founder of the center is Prof. Jean Tran Thanh Van. ***ICISE organises each year >10 conferences and schools, out of that about ~1/3 on astronomy/astrophysics***.

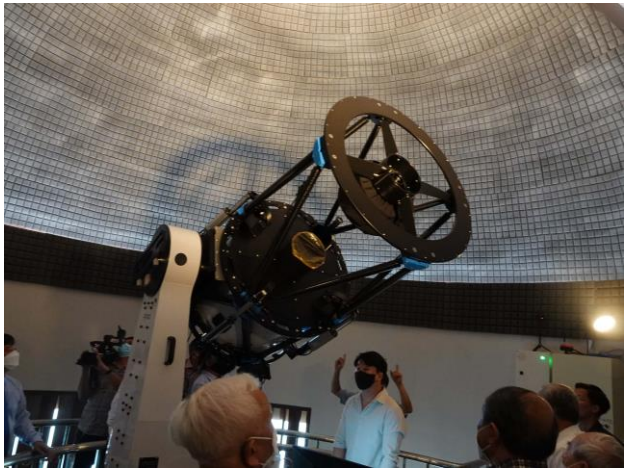
ICISE supported Quy Nhơn city to build a science exploration center for public outreach and education where there are three exhibition rooms, a planetarium, and an observatory.

Quy Nhon Observatory (QNO)



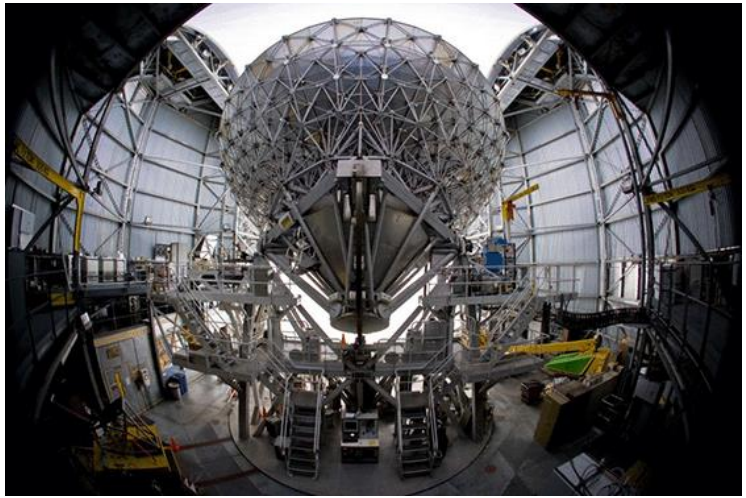
Transit of WASP3b

CDK600



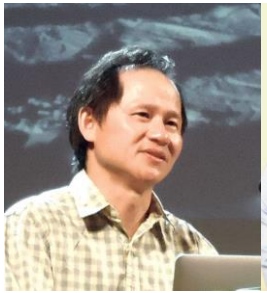
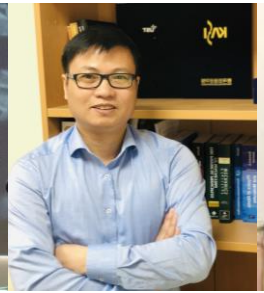
M51

In 2017, Vietnam joined the East Asian Observatory (EAO) as an observer. Vietnamese astronomers can use EAO's facilities.
We actively join the activities of the Observatory: propose/co-proposing telescope observing time, taking shift, serving on the TAC, participating the EAO’s meetings.



The JCMT is the largest single-dish telescope in the world dedicated to detecting submillimetre radiation.

SAGI's Mission

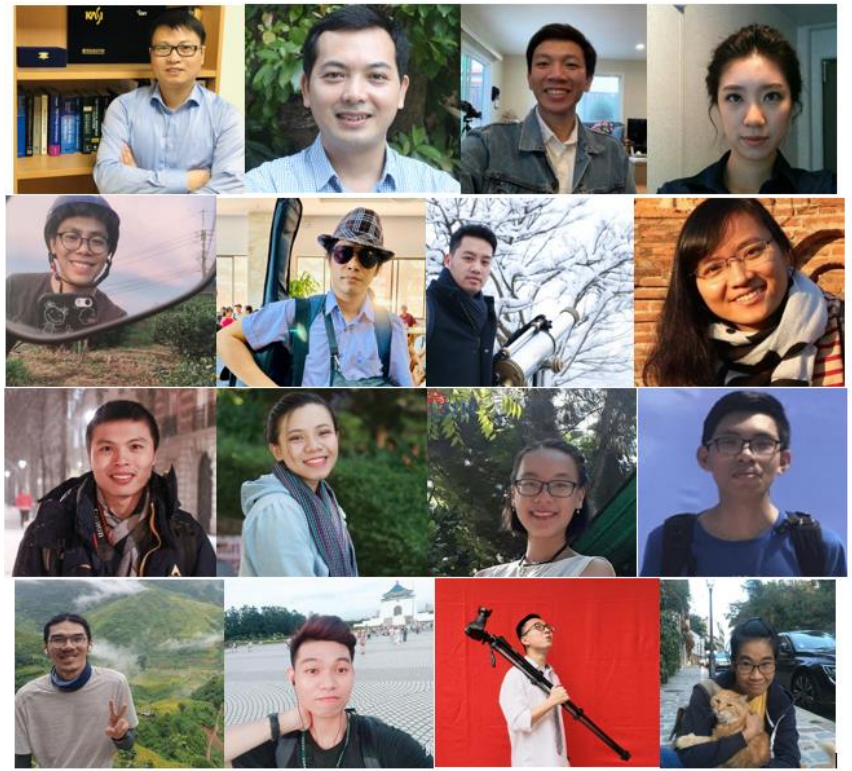

SAGI endeavors to facilitate astrophysics research collaboration between domestic and international researchers

- Training young researchers in astrophysics, and engaging in the science education for the public in the region.
- Meeting point for domestic and overseas Viet researchers.

SAGI
Simons Astrophysics Group at ICISE

Quy Nhơn, July 25, 2022

Vietnam Astrophysics Research Network (VARNET), since November 2020
https://sites.google.com/view/sf2-varnet/



- Organize 3 international workshops
- >15 publications on Q1 journals

6 students were fully funded to follow the grad programs in Korea, France, USA, and UK

Aim: to understand the roles of magnetic fields and dust in star formation and stellar feedback; train young researchers;

Vietnam team at IOAA

2016 India: 1 SM, 4 HMs.

2017 Thailand: 2 SMs, 2 HMs.

2018 China: 1 GM, 1 SM, 2 BMs

2019 Hungary: 1 GM (absolute winner), 3 SMs, 3 BMs, 1 H.M

2020 Global e-Competition on Astronomy and Astrophysics: 1 BM

2021 Colombia: 2 GMs, 1 SM, 2 BMs

2022 Georgia: 1 SM, 5 BMs, 1 HM

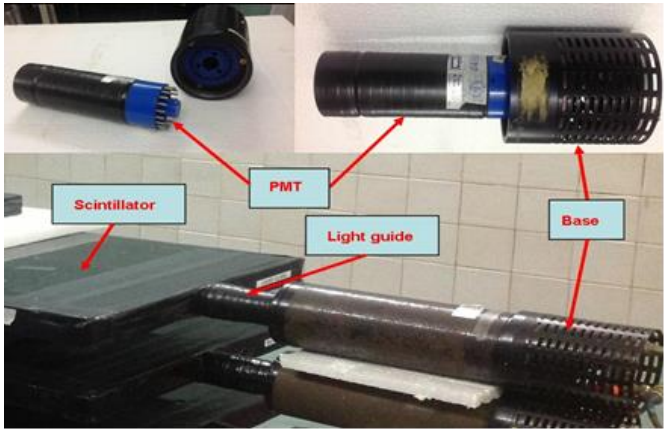
Department of Astrophysics (DAP/VNSC)

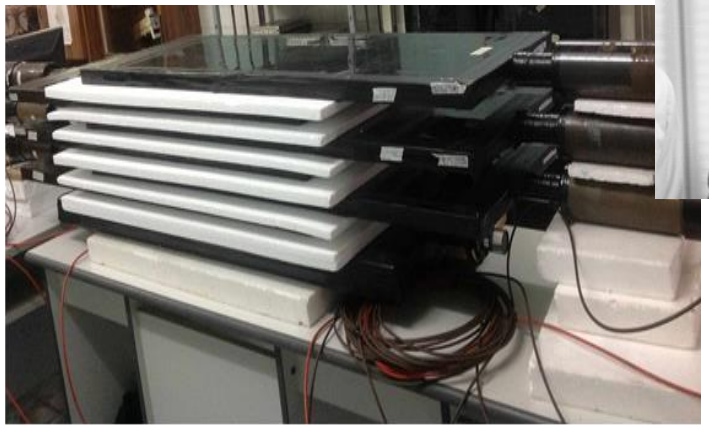
P.N. Diep, P.T. Nhung, P.Tuan-Anh, D.T. Hoai, N.T. Phuong, T.T. Thai, N.B. Ngoc, P. Darriulat

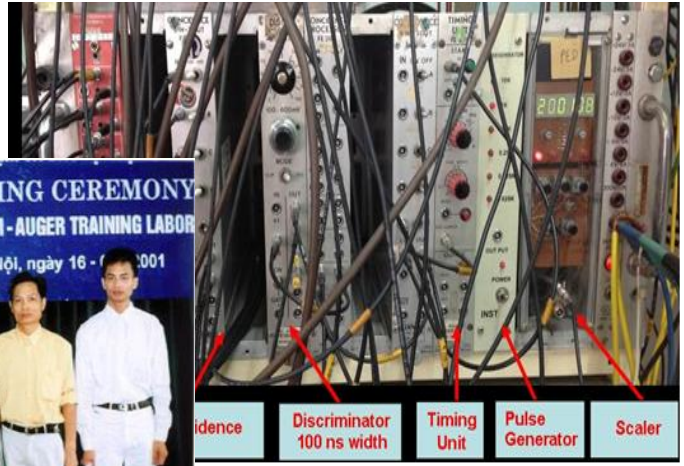
For some ten years, the main interest of the team was the study of very high energy extragalactic cosmic rays in collaboration with the Pierre Auger Observatory in Argentina.

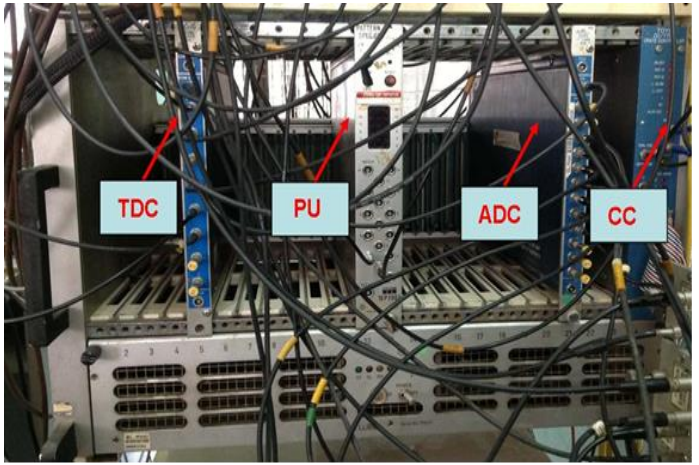
We also developed and operated detectors of our own at home, with which we measured the flux and asymmetry of atmospheric cosmic neutrinos on the geomagnetic equator [Nuclear Physics B, 627(2002)29, 661(2003)302 and 678(2004)3].

Our team was established in 2001 by Prof. Pierre Darriulat when he came to Vietnam with detectors.



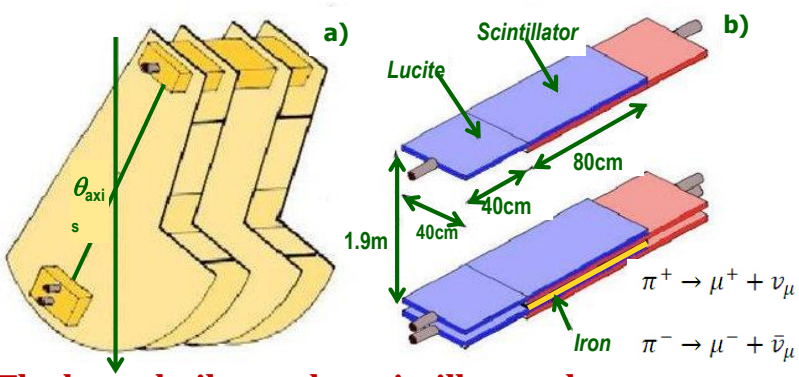


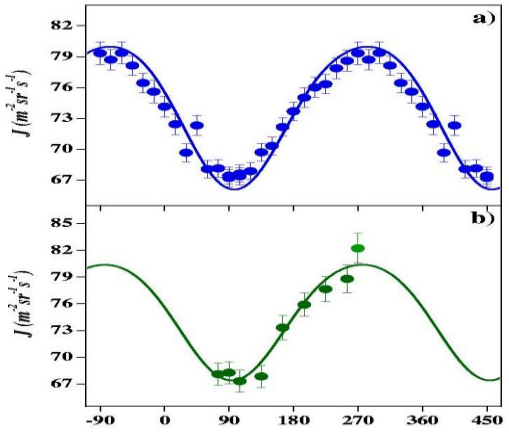




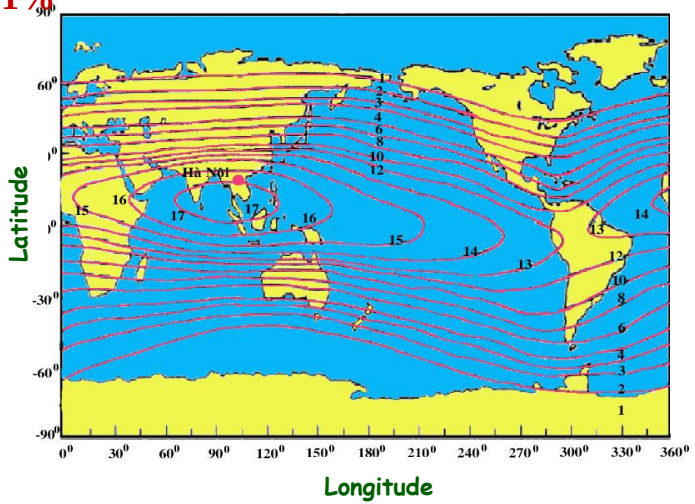
Instrumentation

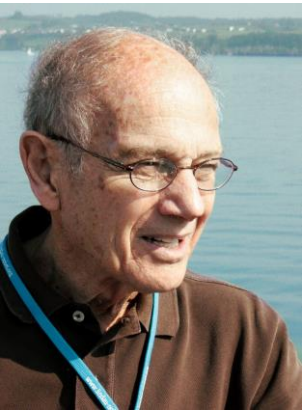
Measurement of cosmic muon flux in Hanoi





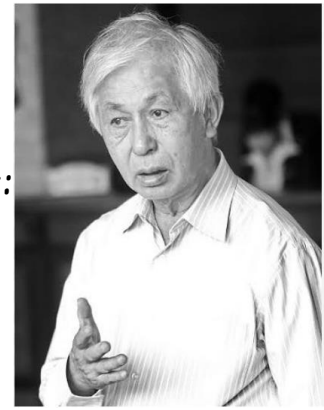
The home built wooden scintillator telescope measured the muon fluxes with a precision of 1%





We immediately joined the

Pierre Auger Observatory

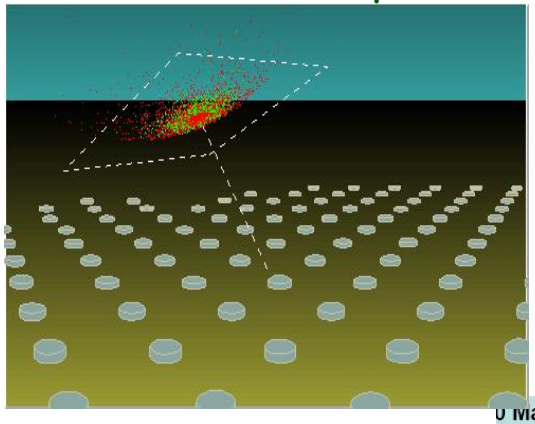


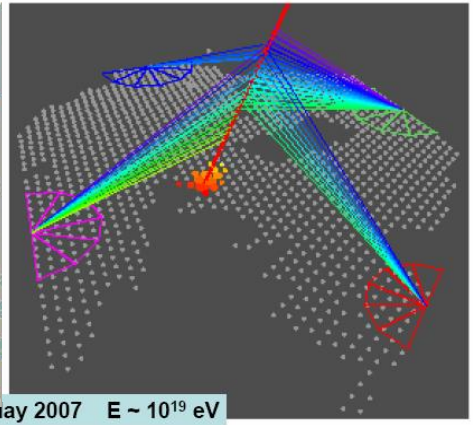
The Auger Observatory is the first large hybrid detector ever built: it combines the strengths of

Surface Detector Array & Air Fluorescence Detectors

THE PHYSICS OF ULTRA HIGH ENERGY COSMIC RAYS

- Accurate measurement of the high end of the energy spectrum
- Identification of possible sources
- Nature of the primaries



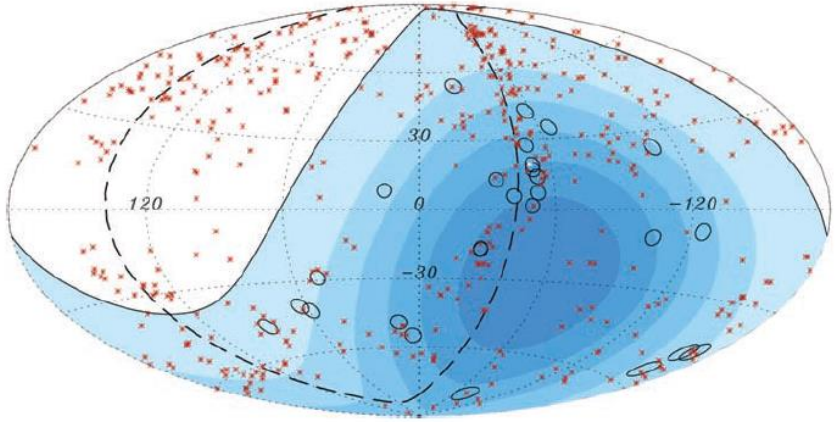


0 May 2007 E ~ 10^{19} eV

Science
AAAS

Correlation of the Highest-Energy Cosmic Rays with Nearby Extragalactic Objects
The Pierre Auger Collaboration, *et al.*
Science **318**, 938 (2007);
DOI: 10.1126/science.1151124

Top ten physics event of APS



Three of us have made our PhD theses in this field. We made significant contributions to the very successful achievements of this program.

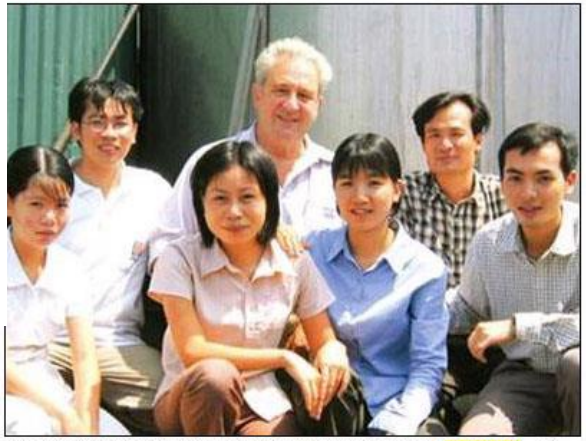
TRANG NHẤT
Thời sự - Xã hội
Kinh tế
Thanh niên-Thời đại
Sau lũy tre làng
Phóng sự
Bạn đọc & Tiền phong
RSS
TRỰC TUYẾN
THÔNG TIN CẦN BIẾT
Thời tiết

KHOA HỌC-CÔNG NGHỆ

Thứ Sáu, 09/11/2007, 06:26

Nhóm Vật lý Việt Nam là đồng tác giả trong phát hiện về tia vũ trụ

P - Các nhà khoa học vừa kết luận: Các trung tâm thiên hà AGN ới lỗ đen siêu nặng đang hoạt động mạnh là nguồn phát khả dĩ hất của tia vũ trụ năng lượng cao đến trái đất. Đáng chú ý, phát inh này có đóng góp của các nhà vật lý trẻ VN.



Các nhà vật lý trẻ thuộc phòng thí nghiệm VATLY và GS Pierre Darriulat - Cố vấn khoa học của Dự án

Phát hiện này nằm trong dự án thí nghiệm Pierre Auger và được đăng trên tạp chí *Science* số ra hôm nay, 9/11.

High energy cosmic rays

Collaboration with the Pierre Auger Observatory in Argentina

Radio astronomy

Collaboration with French institutes
Using 2.6 m radio telescope at home

Radio astronomy is at the forefront of current research; observations made from major international observatories; availability of archival ALMA observations 1 year after they were taken.

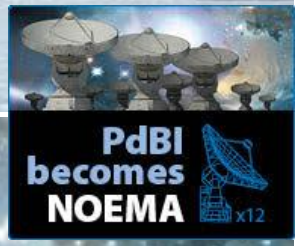
For training students at home, it is much better adapted to the Vietnamese tropical sky than optical astronomy, for which observations are rarely possible.

We now work exclusively in radio astronomy.

We use observations made with **radio interferometers**:
Plateau de Bure (6 antennas) and ALMA (66 antennas).

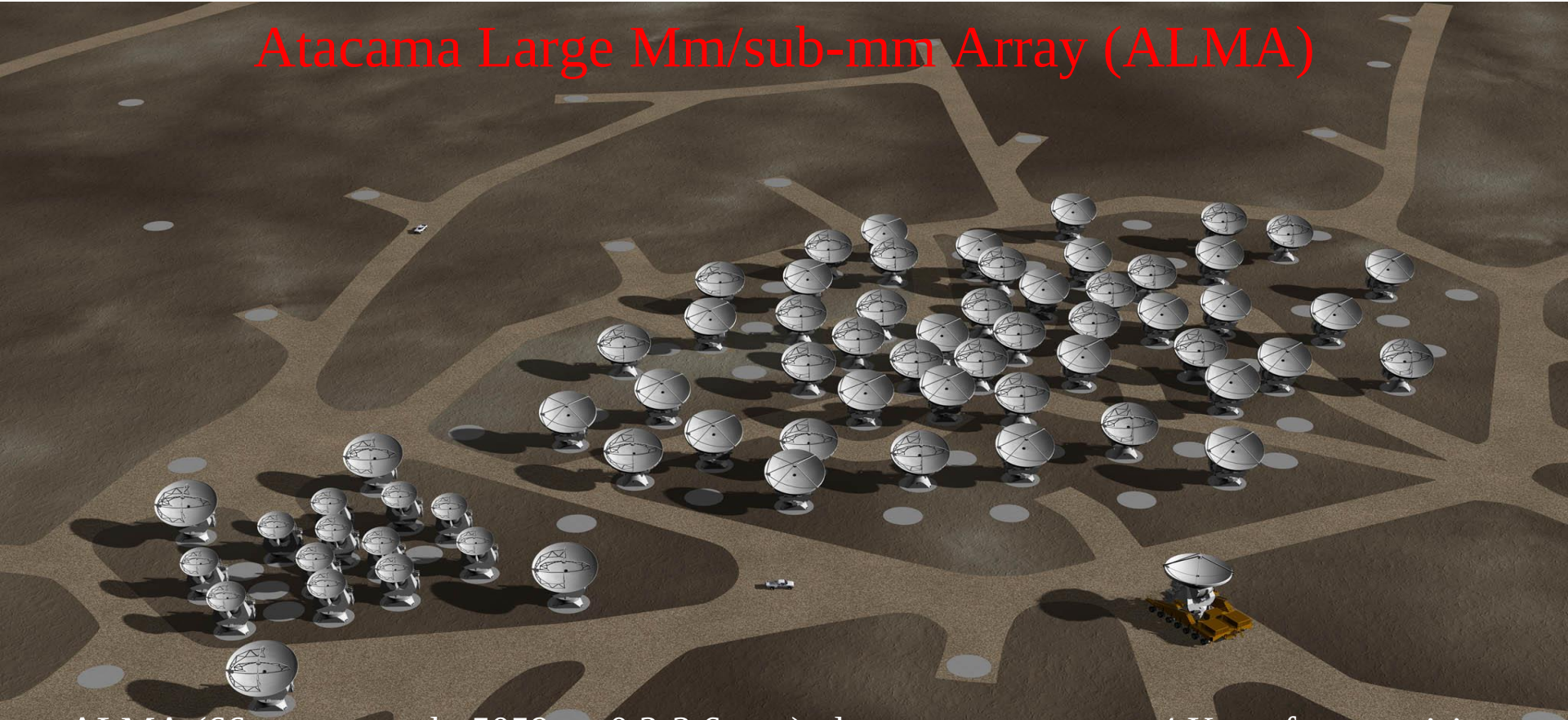
Data

Plateau de Bure (PdBI)



NOEMA (NOrthern Extended Millimeter Array)

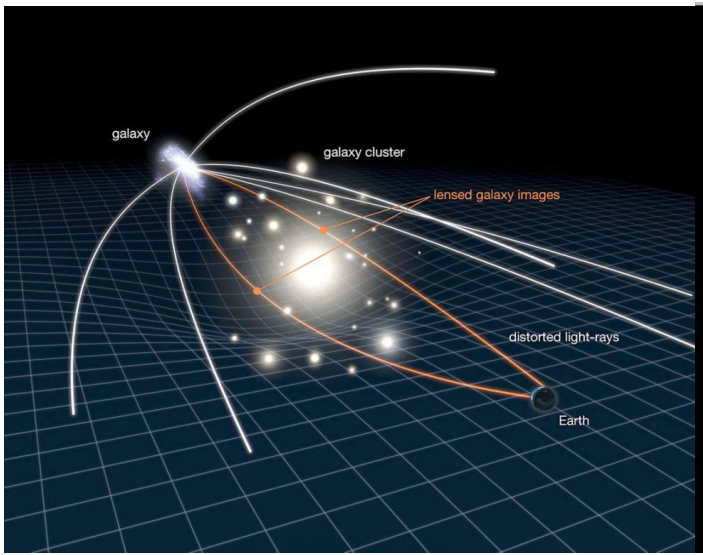
Atacama Large Mm/sub-mm Array (ALMA)



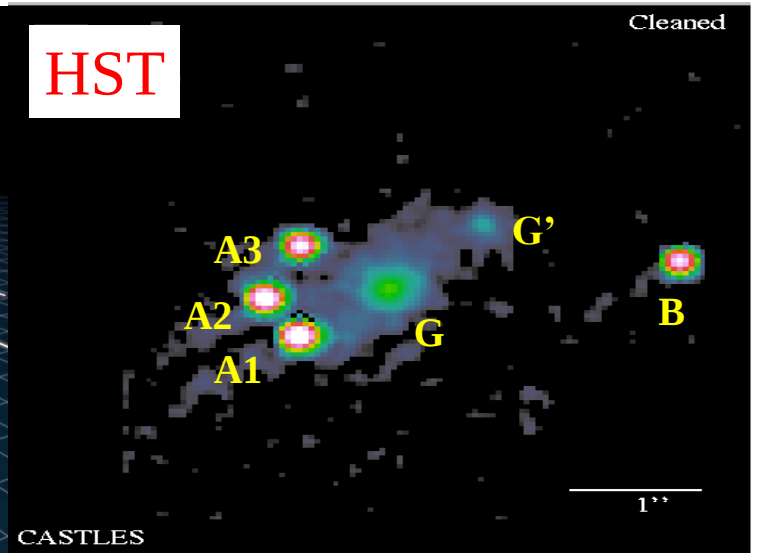
ALMA (66 antennas, alt. 5059 m, 0.3-3.6 mm), detector temperature 4 K, surface precision 20 μm, no significant rainfall between 1570 and 1971.
Since Cycle 8 (1/10/2021), ALMA adds the full-polarization capability.

High redshift galaxies: a typical example, RX J0911

RX J0911: the host galaxy of a gravitationally lensed high redshift quasar (z~2.8, look back 11.3 Gyr). Detection of the CO(7-6) line by Plateau de Bure measures its gas content; and of the continuum underneath by ALMA, its dust content.

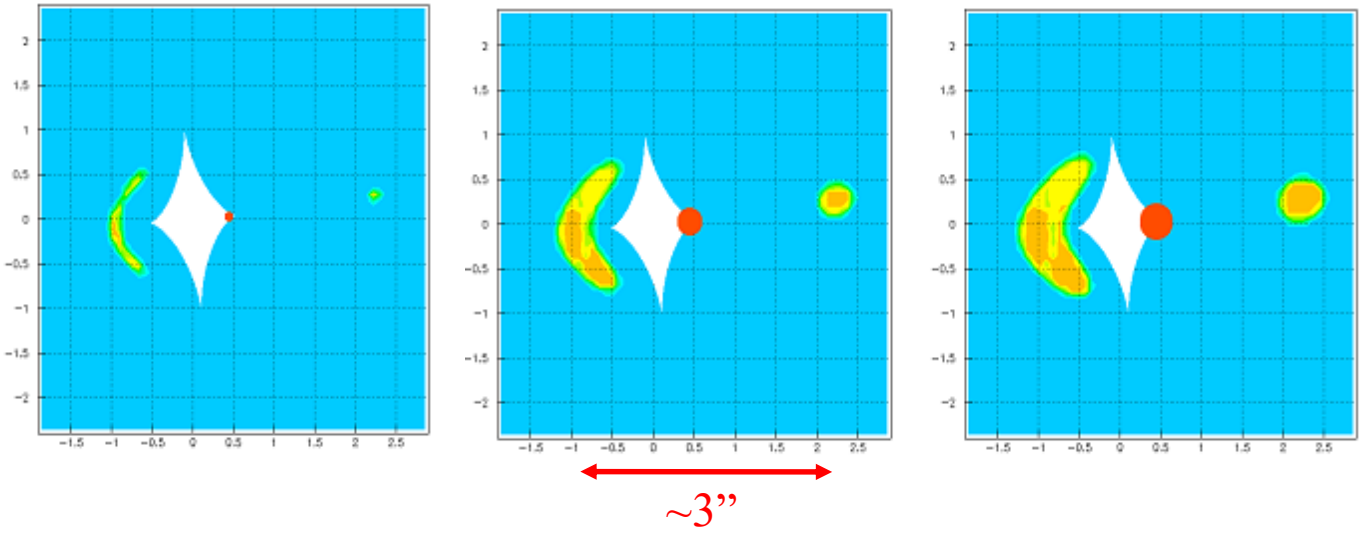


Gravitational lensing effect



RX J0911

Lensing is complicated by the fact that the extended source overlaps the lens caustic. We studied this peculiar situation in detail.

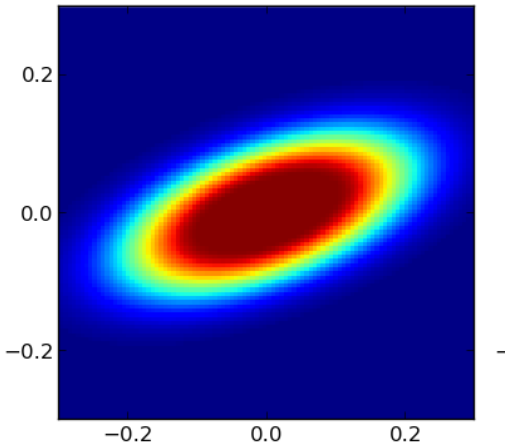


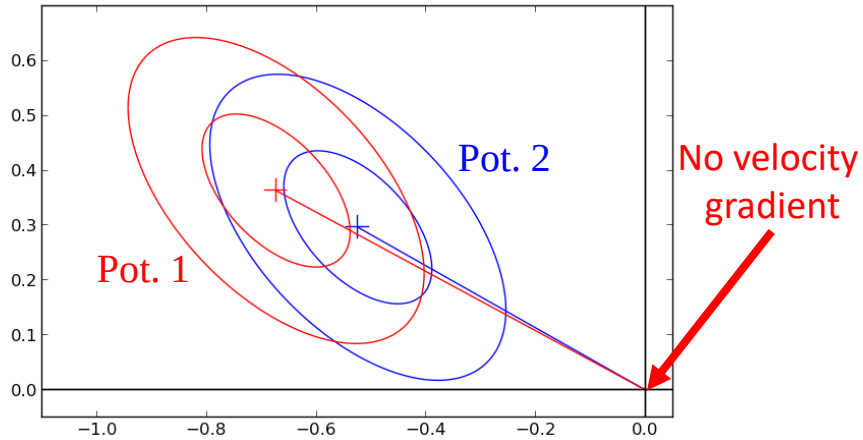
RX J0911: Gas properties

The gas source has a **radius of 850±120 pc** on the line (~7 s.d.) and provide evidence for **ellipticity** and for a significant **velocity gradient** (molecular outflow and/or rotation).

Ellipticity: 3.3 s.d. away from circular

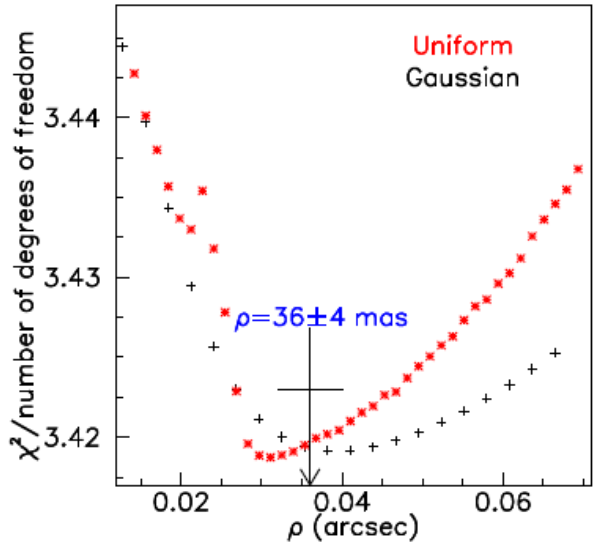
Evidence for velocity gradient at 4.5 s.d.





RX J0911: Dust component

The dust component is found much more compact than the gas component, ~3.4±0.4 times less extended and too small to allow for an ellipticity measurement.

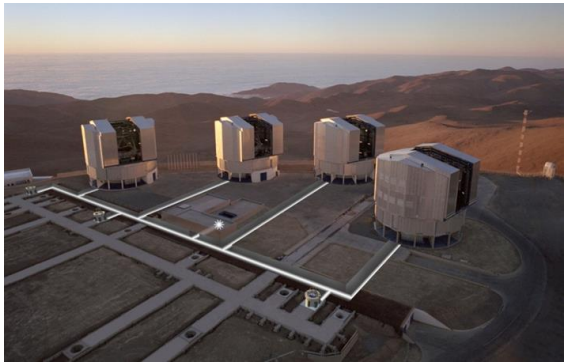


This measurement makes RX J0911 one of the few high-z galaxies for which the dust and gas are resolved with dimensions being measured.

The sources of Cosmic-reionization as seen by MUSE/VLT

(Cotutelle PhD thesis between Marseille and Hanoi)

Student: Tran Thi Thai

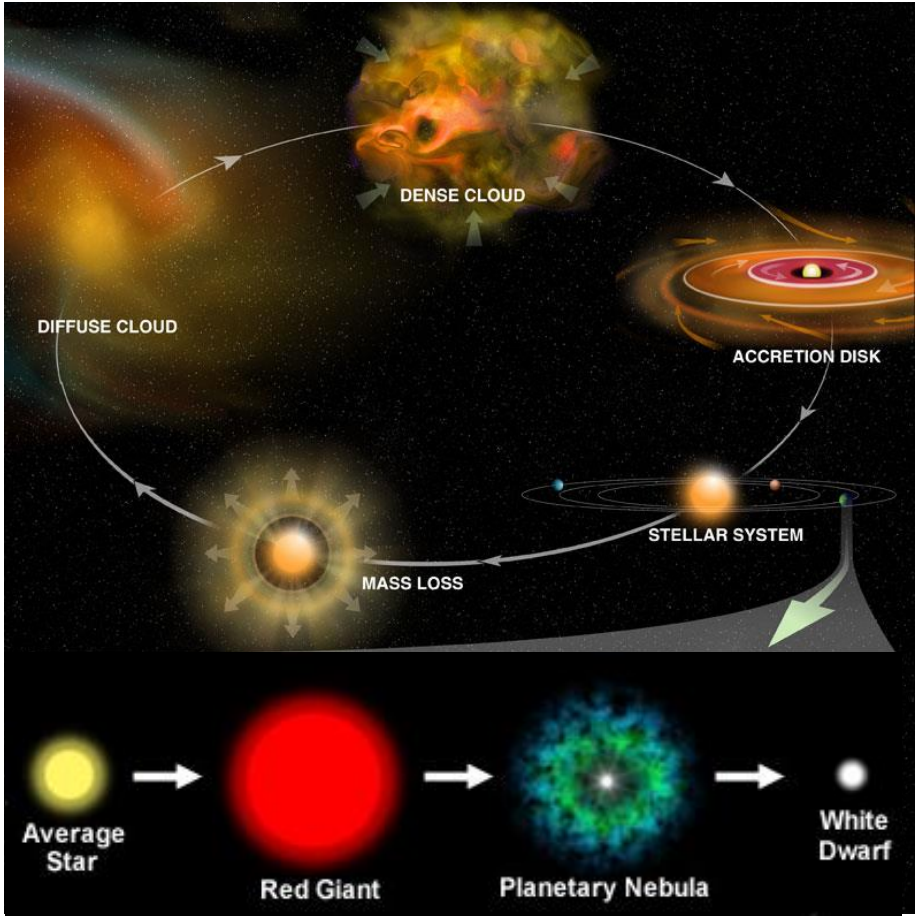


Supervisors: Pr. Roser Pello (France)
Dr. Pham Tuan-Anh
(Vietnam)

Hanoi, April 2021

See the talk by Pham Tuan Anh on Tuesday

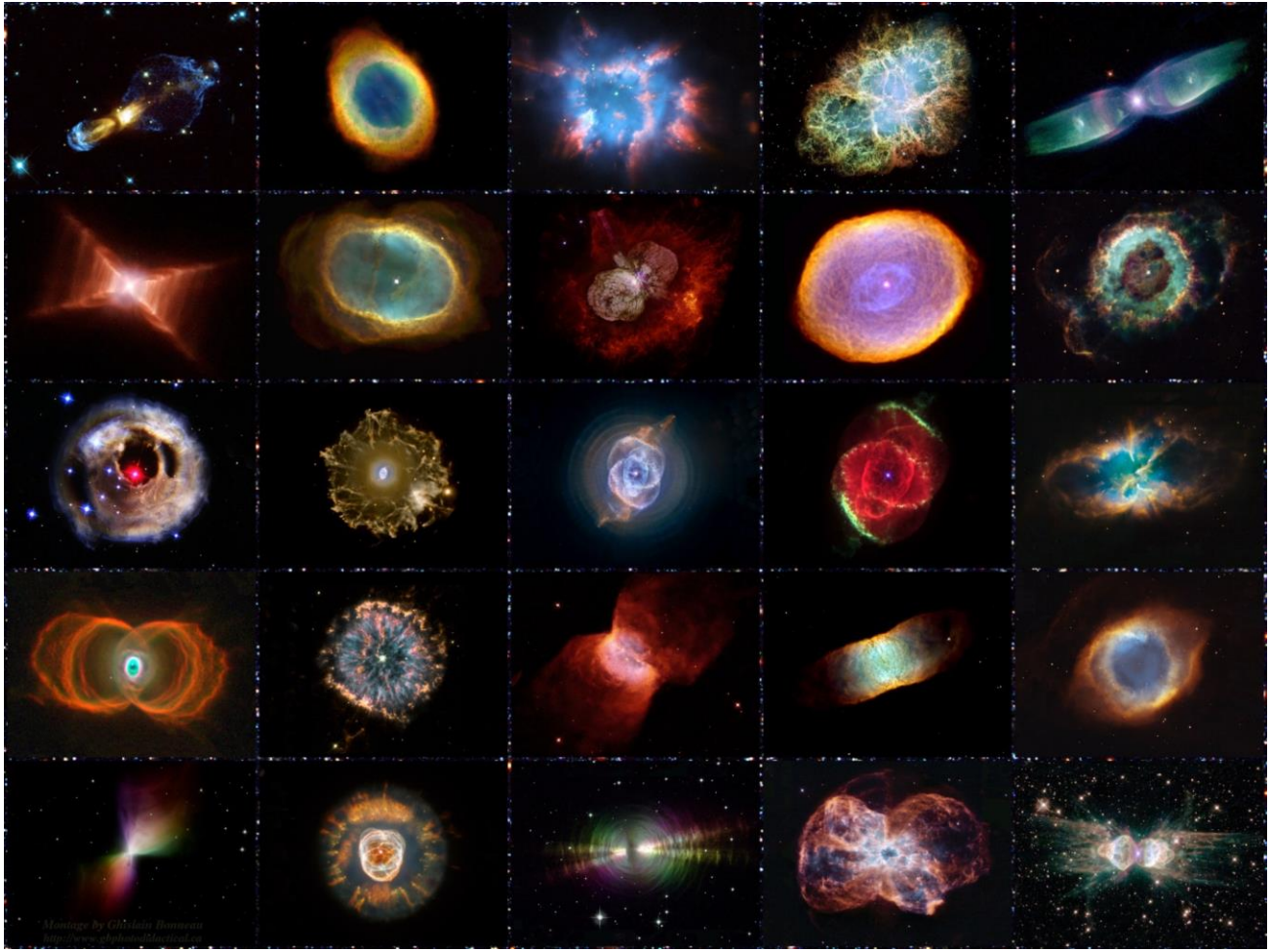
Stellar Physics



Star formation

Evolved star

What are the symmetry breaking mechanism?

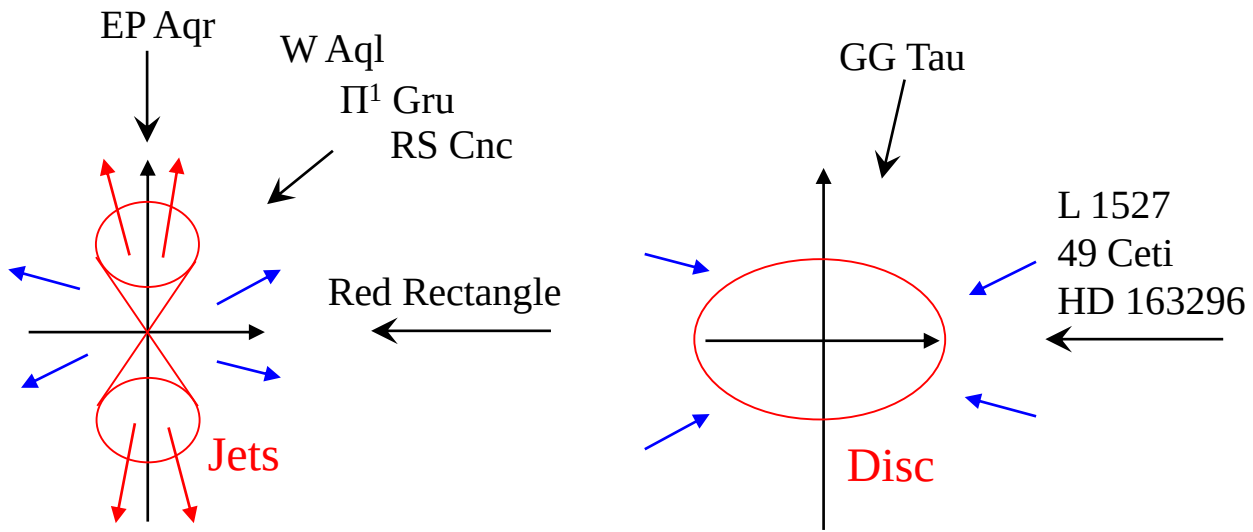


A Hubble Space Telescope sampler of planetary nebulae (*NASA/ESA)*

Evolved stars and protostars are studied using high resolution continuum and line emissions from dust and molecules. The former often feature a **bipolar molecular outflow**, the latter the formation of a **disc**.

See the mini review talk by Do Thi Hoai on Wednesday

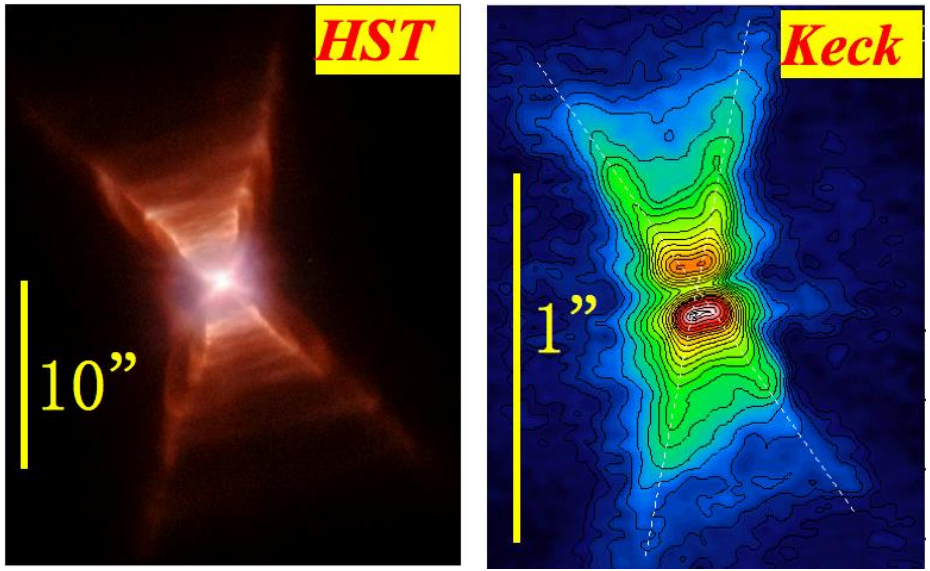
Mira Ceti, R Dor, L2 Pup, O Cet, W Hya, R Leo

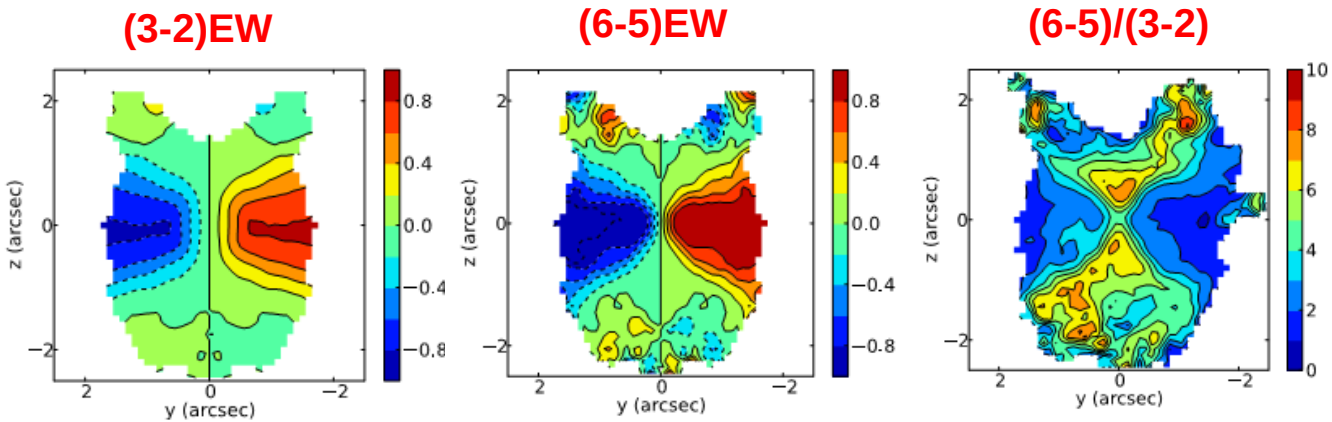


Space reconstruction: P.N. Diep et al., MNRAS, 461, 4276 (2016)
P.T. Nhung et al., MNRAS, 480, 3324 (2018).

An evolved star, the Red Rectangle

The Red Rectangle is a Post-AGB source, having its axis perpendicular to the line of sight.
We studied CO(6-5) and (3-2) emissions measured by ALMA (archival data of unprecedented quality).





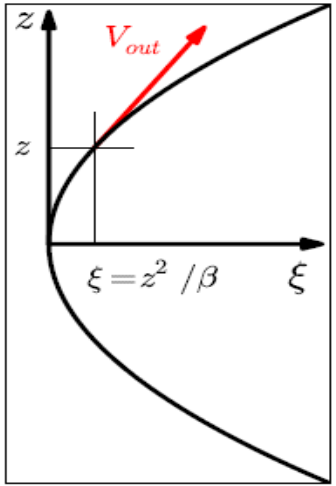
East-West Doppler velocity asymmetry reveals a very clear **rotation of the equatorial region** about the star axis.

CO(6-5)/CO(3-2) intensity map provides evidence for a **temperature distribution** dominated by the biconical structure down to low distances from the star.

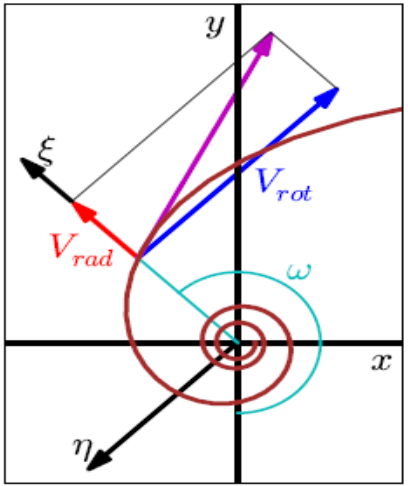
Gas kinematics

Polar regions: parabolic meridian trajectories joining smoothly between the equatorial torus and the star axis with a constant wind velocity.

Equator region: spiraling trajectories with rotation and expansion.



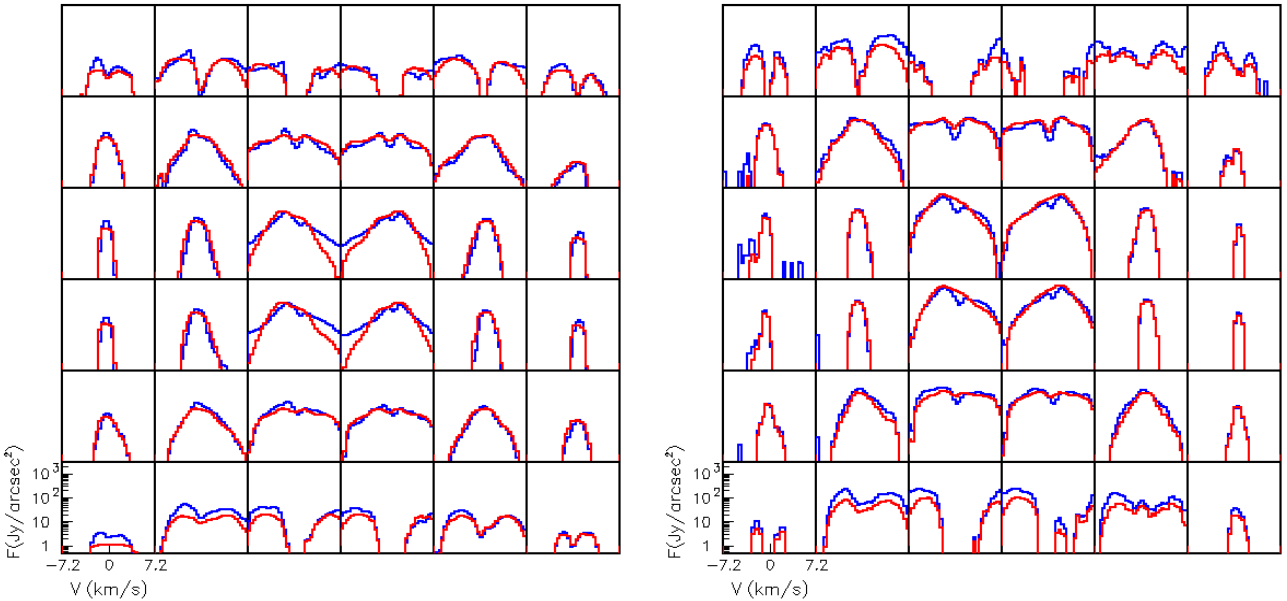
Polar region



Equatorial region

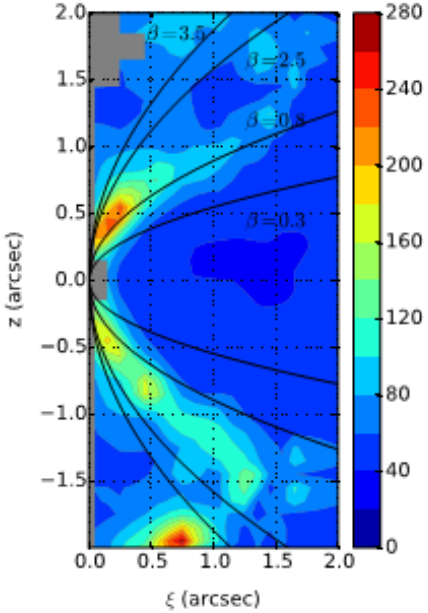
Results

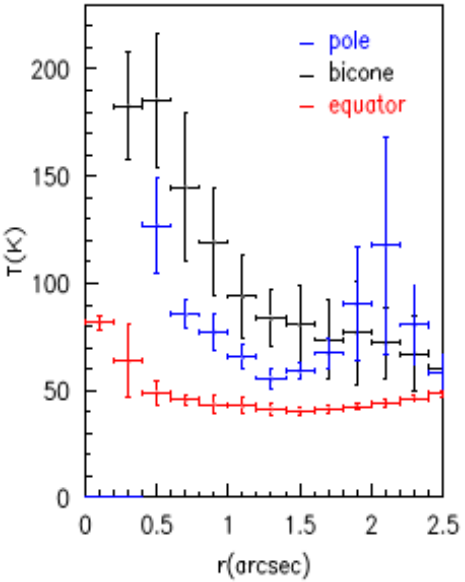
We find V_{rot}~*1.0 km/s*, V_{rad}~*1.6 km/s*



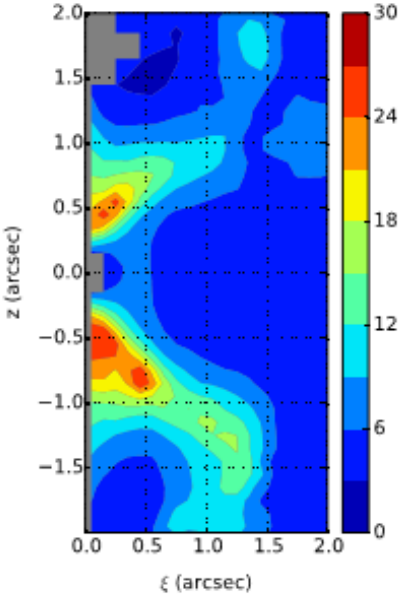
The fit is surprisingly good in view of the crudeness of the model.

Temperature





Density×r^2



The gas morphology is reconstructed in space (here shown in the meridian plane): sharp separation between the equatorial and polar regions.

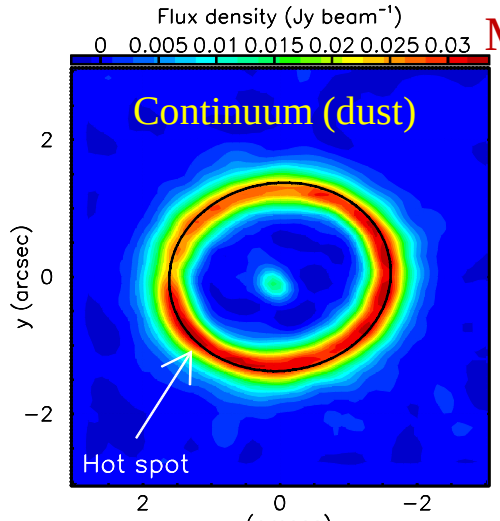
A protostar: GG Tau

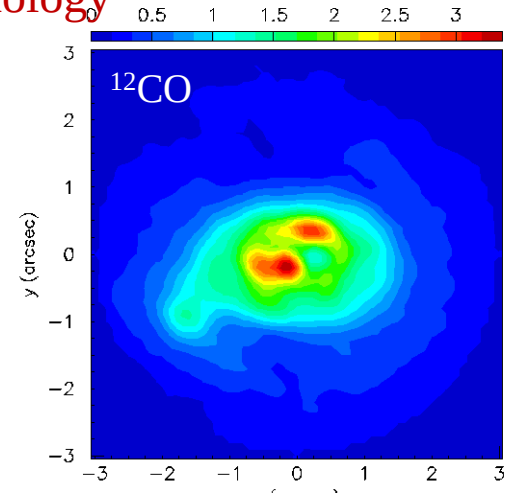
GG Tau is a triple star, with respective separations of 35 au and 4.5 au. It is located at 140 pc in the Taurus molecular cloud. Surrounded by a circumbinary envelope of gas and dust with a **ring spanning from ~190 to 280 au** and an **outer disc extending up to ~800 au** from the protostar with a total mass ~0.15 solar masses.

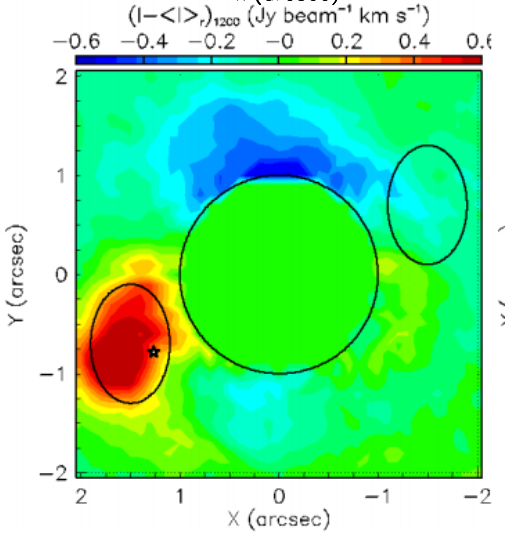
Artist view

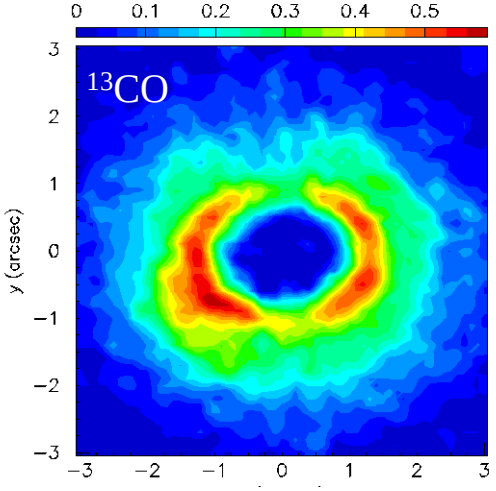
Main questions address the morphology and kinematics of the surrounding gas and dust, the complex chemistry at stake (strongly influenced by dust grains) and the possible formation of planets.

Morphology


Flux density (Jy beam^{-1})
0 0.005 0.01 0.015 0.02 0.025 0.03
Continuum (dust)
Hot spot
y (arcsec)
x (arcsec)

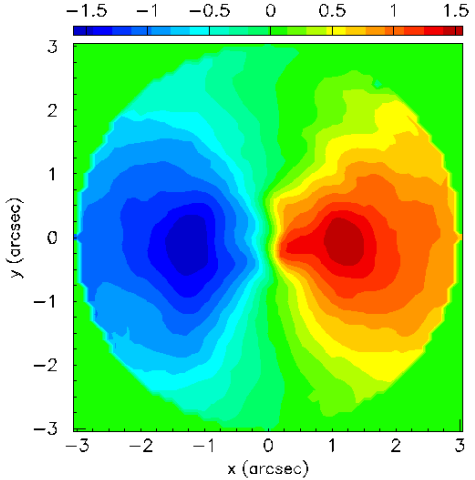

0 0.5 1 1.5 2 2.5 3
^{12}CO
y (arcsec)


$(I-<I>_r)_{12CO}$ (Jy beam^{-1} km s^{-1})
−0.6 −0.4 −0.2 −0 0.2 0.4
Y (arcsec)
X (arcsec)

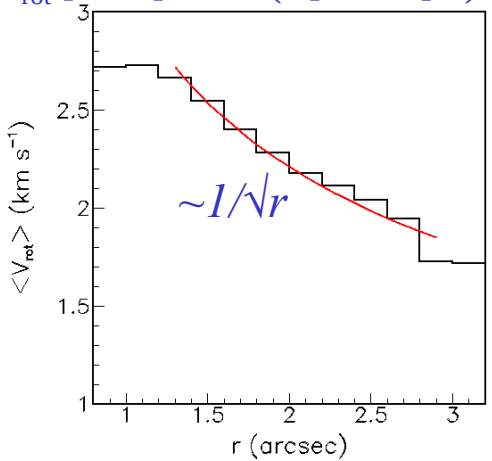

0 0.1 0.2 0.3 0.4 0.5
^{13}CO
y (arcsec)

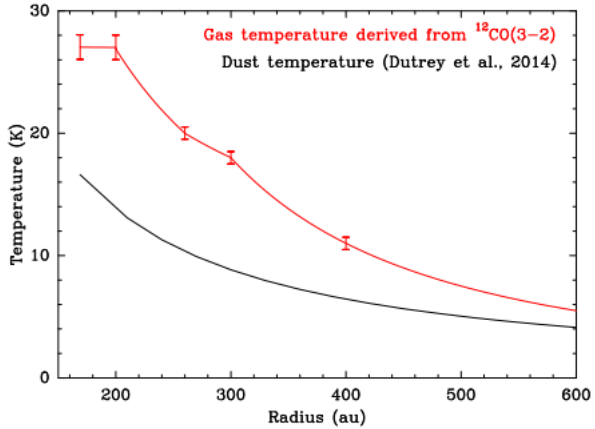
Kinematics and Physical Condition

The ring is in Keplerian rotation:
V_{rot} [km/s]= 2.21(r [arcsec]/2) $^{-0.48}$



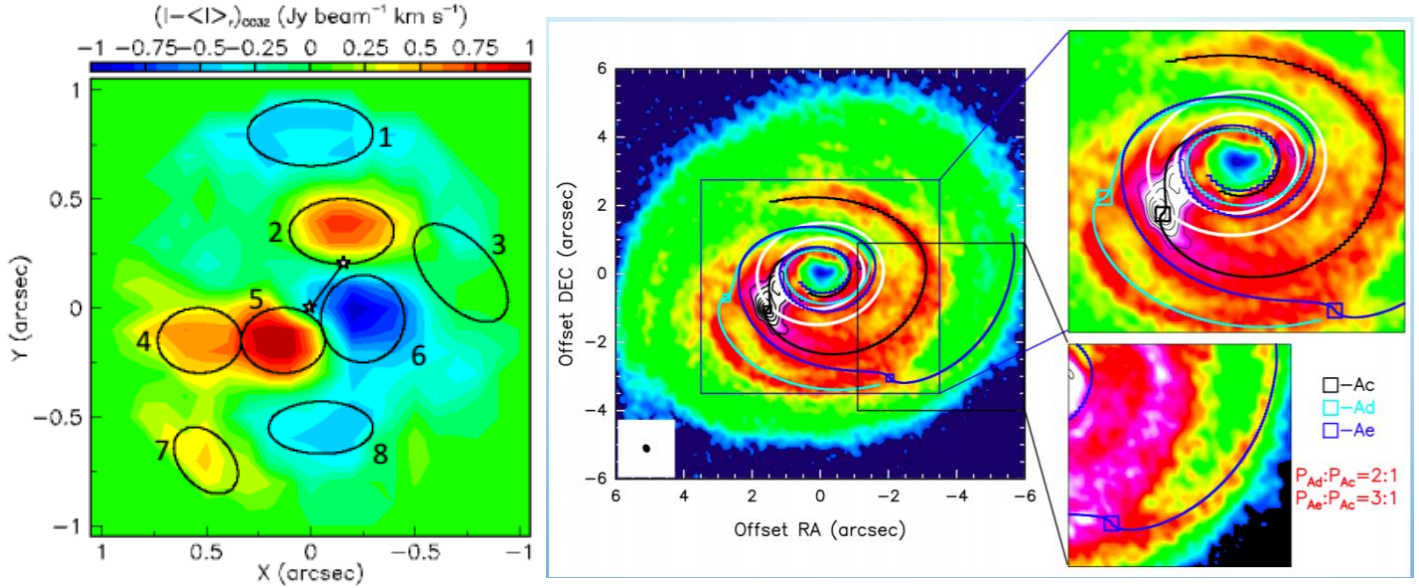
Upper limit of infall
Measure the thickness of the disk





Cavity and Chemistry

See the talk by Nguyen Thi Phuong this afternoon



N. T. Phuong, P.N. Diep, A. Dutrey, (2018, 2020a, 2020b).

A&A 616, L5 (2018)

Letter to the Editor

First detection of H_2S in a protoplanetary disk

The dense GG Tauri A ring

N. T. Phuong[1,2,3], E. Chapillon[1,4], L. Majumdar[5], A. Dutrey[1], S. Guilloteau[1], V. Piétu[4], V. Wakelam[1], P. N. Diep[2,3], Y.-W. Tang[6], T. Beck[7] and J. Bary[8]

A&A 653, L5 (2021)
https://doi.org/10.1051/0004-6361/202141881

Astronomy & Astrophysics

LETTER TO THE EDITOR

An unbiased NOEMA 2.6 to 4 mm survey of the GG Tau ring: First detection of CCS in a protoplanetary disk

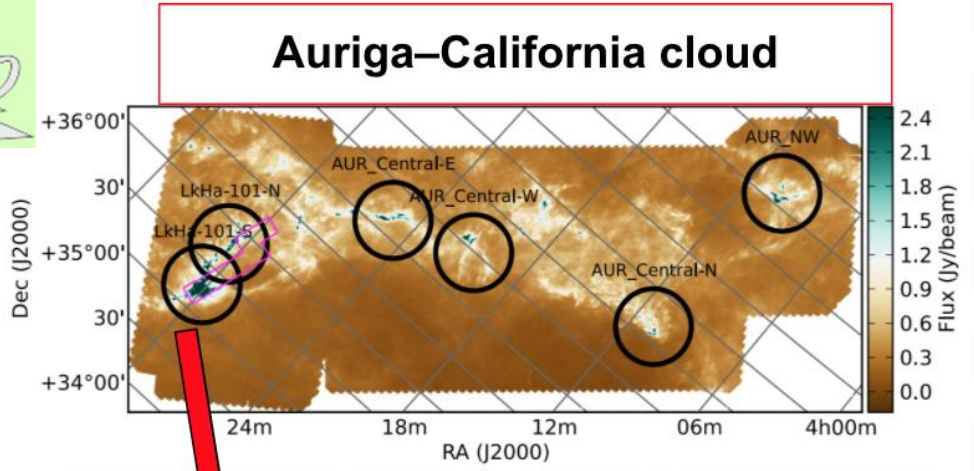
N. T. Phuong[1,2], A. Dutrey[3], E. Chapillon[3,4], S. Guilloteau[3], J. Bary[5], T. L. Beck[6], A. Coutens[7], O. Denis-Alpizar[8], E. Di Folco[3], P. N. Diep[2], L. Majumdar[9], J.-P. Melisse[3,4], C.-W. Lee[1,10], V. Pietu[4], T. Stoecklin[11], and Y.-W. Tang[12]

Magnetic fields in star forming regions; Polarization and Dust physics

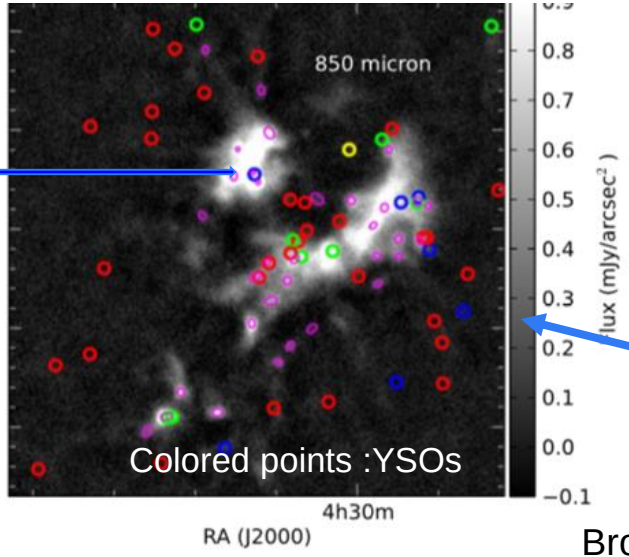
LkHα 101 Region

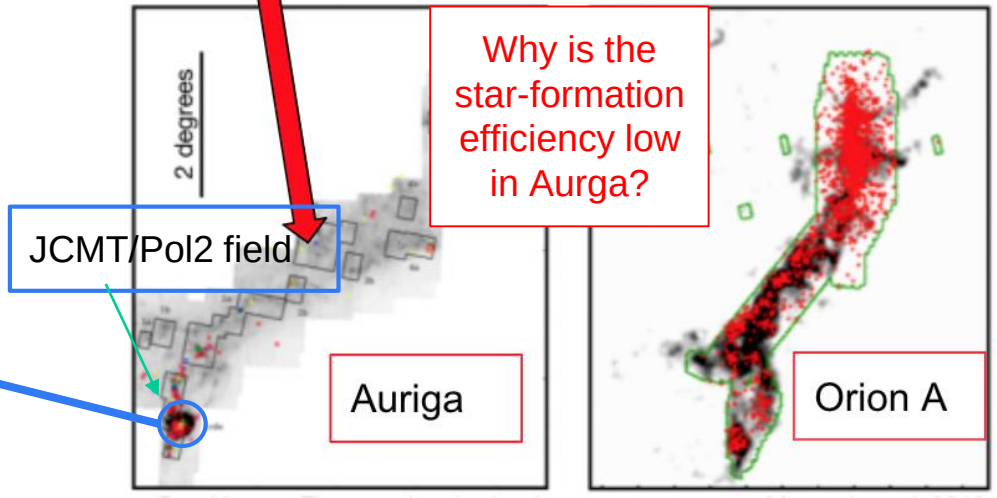
Highest star-formation efficiency in Auriga-California cloud

33 candidate protostars with **only one early-B star (LkHα 101)**



LkHα 101



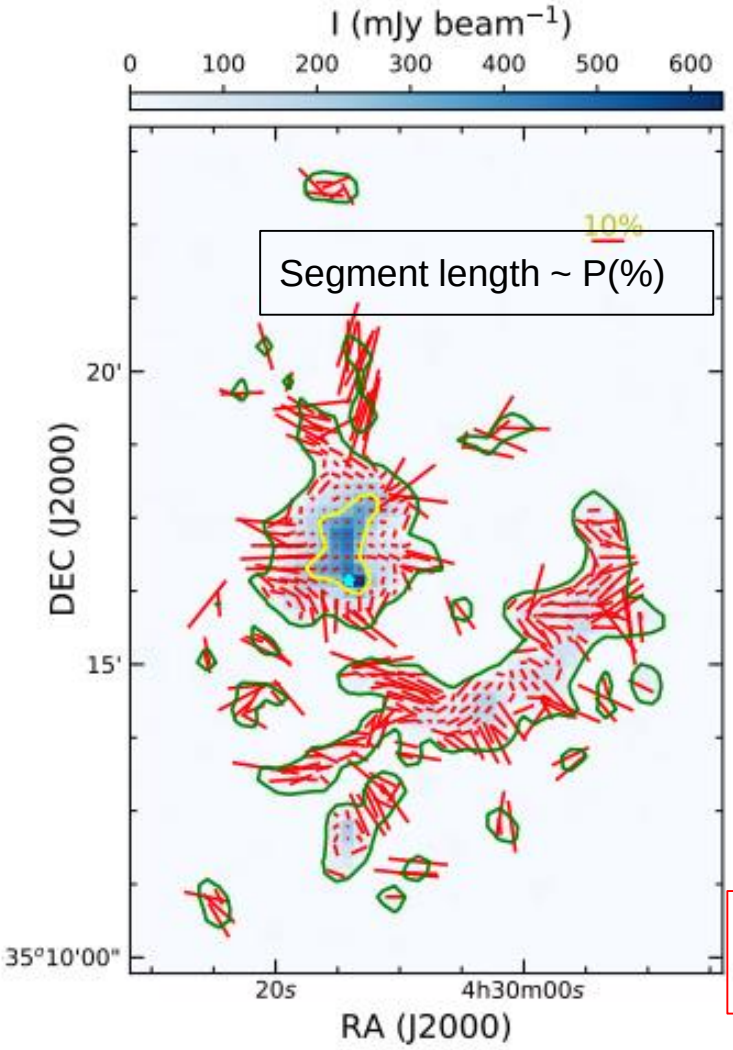


Why is the star-formation efficiency low in Aurga?

red dots: protostars

Broekhoven-Fiene+ 2018

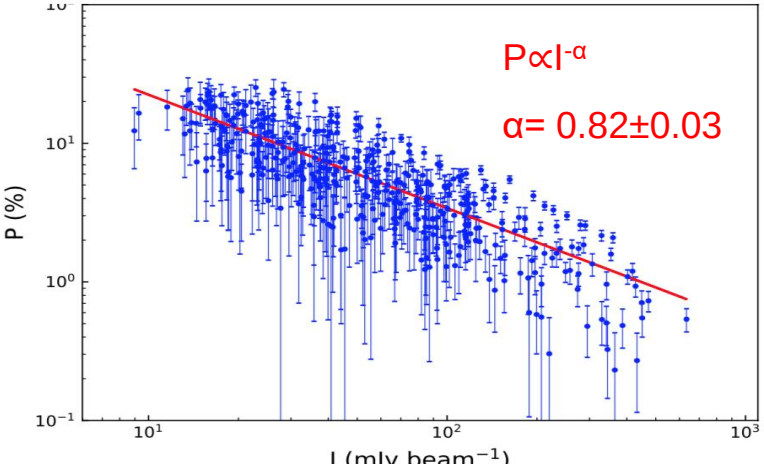
Polarization hole

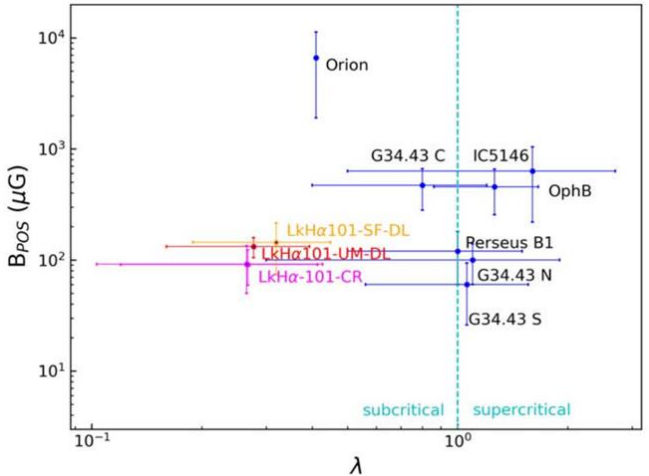


Causes

disorganized B-field lines smeared out in the synthesized beam (field tangling)

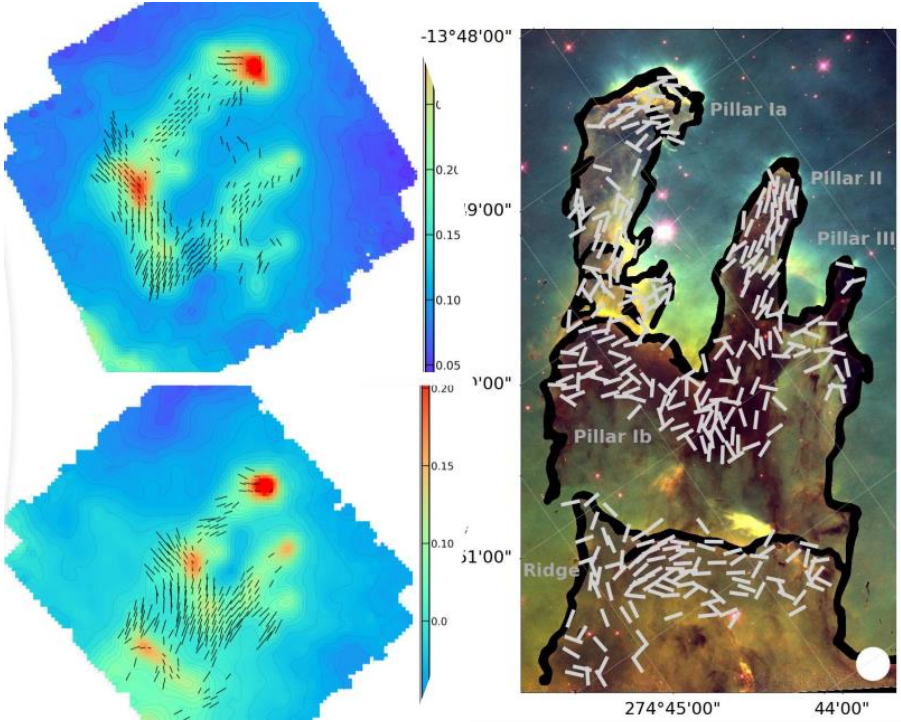
lack of irradiation, RAT disruption, and/or changes in dust grain characteristics toward high column density regions



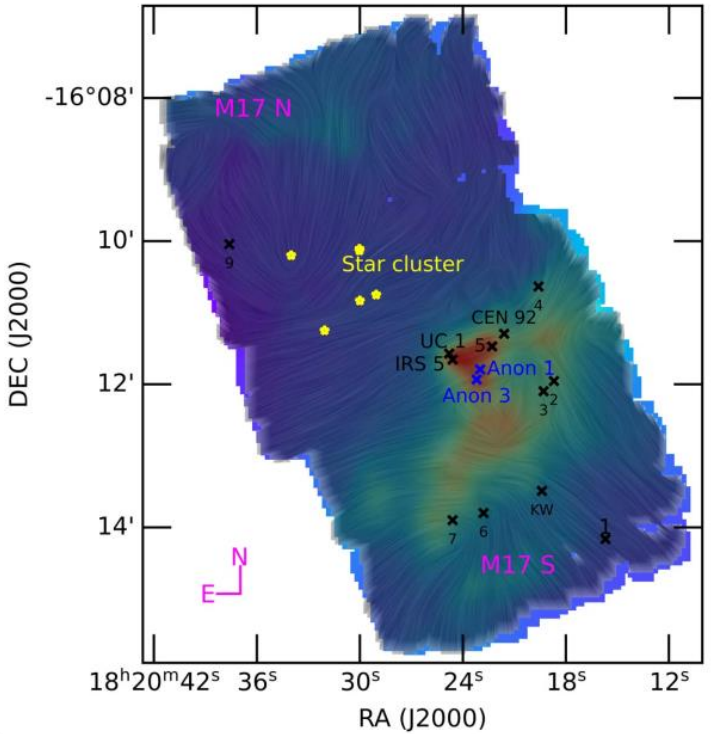


Ngoc et al., ApJ, 2021
for BISTRO Collaboration

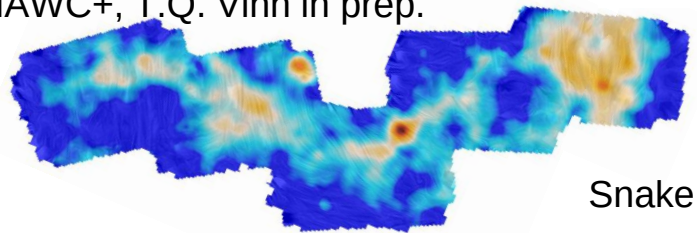
M16, M17, and the Snake filament: morphology, strength, relative role, grain alignment and properties



M16, SOFIA/HAWC+, T.Q. Vinh in prep.

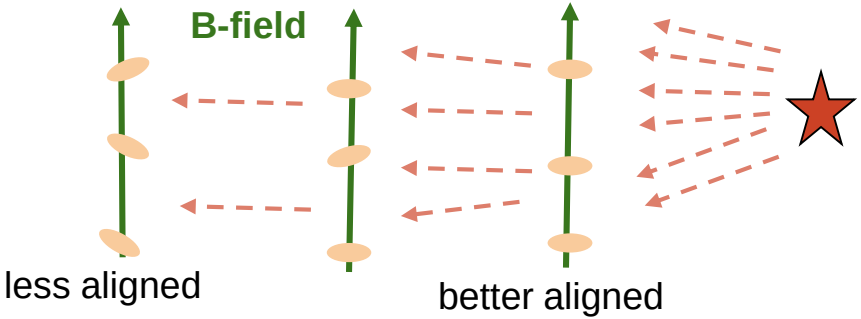


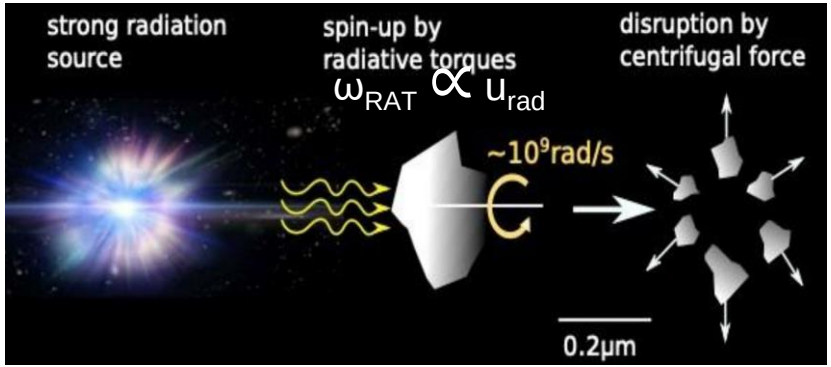
M17, SOFIA/HAWC+, H.D. Thuong+ (2022)



Snake filament, N.B. Ngoc+ (2023)

Test the predictions of RAdiative Torque Disruption (RATD)



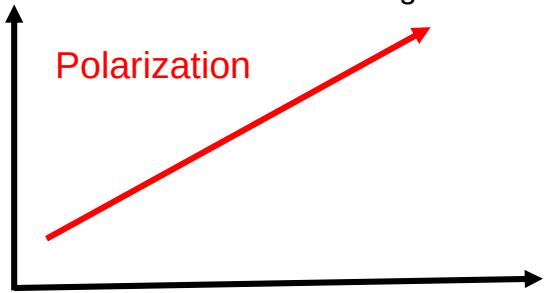


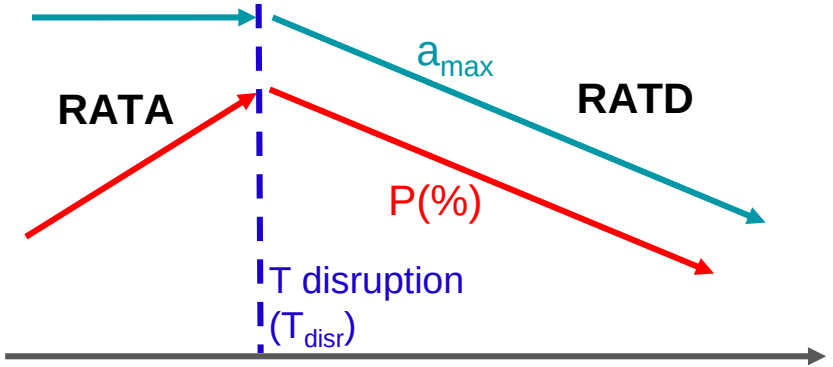
RATA prediction:
P (%) increases with increasing T_{dust}

RATD prediction:
P (%) increases and then decreases with increasing T_{dust}

Hoang, Tram + 2019

E.g. Lazarian & Hoang 2007





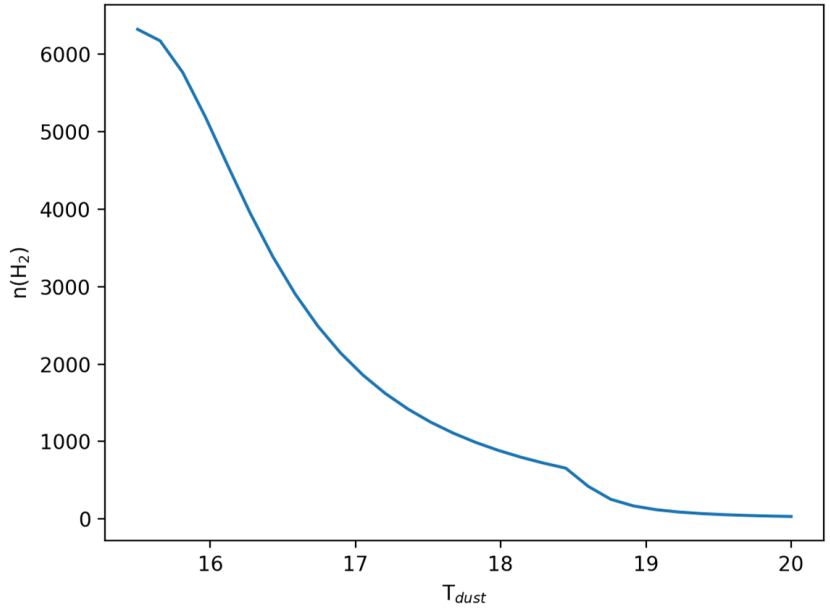
Radiation strength ~ Dust temperature (T_{dust})

Musca: Numerical setup

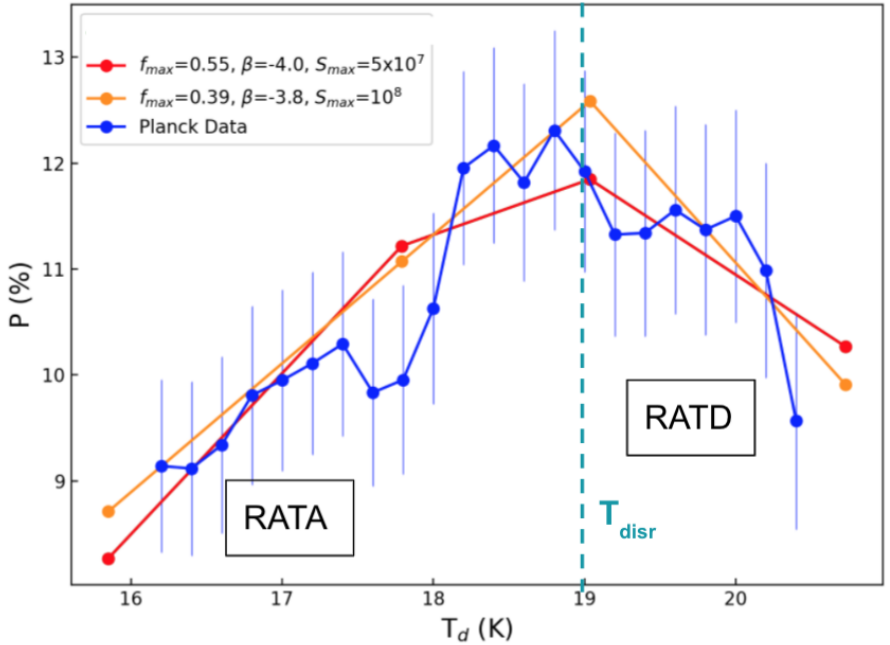
Volume density profile

Temperature profile

Correlation of T_{dust} and $n(H_2)$



Result



$T_{dust}<T_{disr}$: low T_{dust} and high $n(H_2)$

=> no RATD => P(%) increases as T_{dust} increases

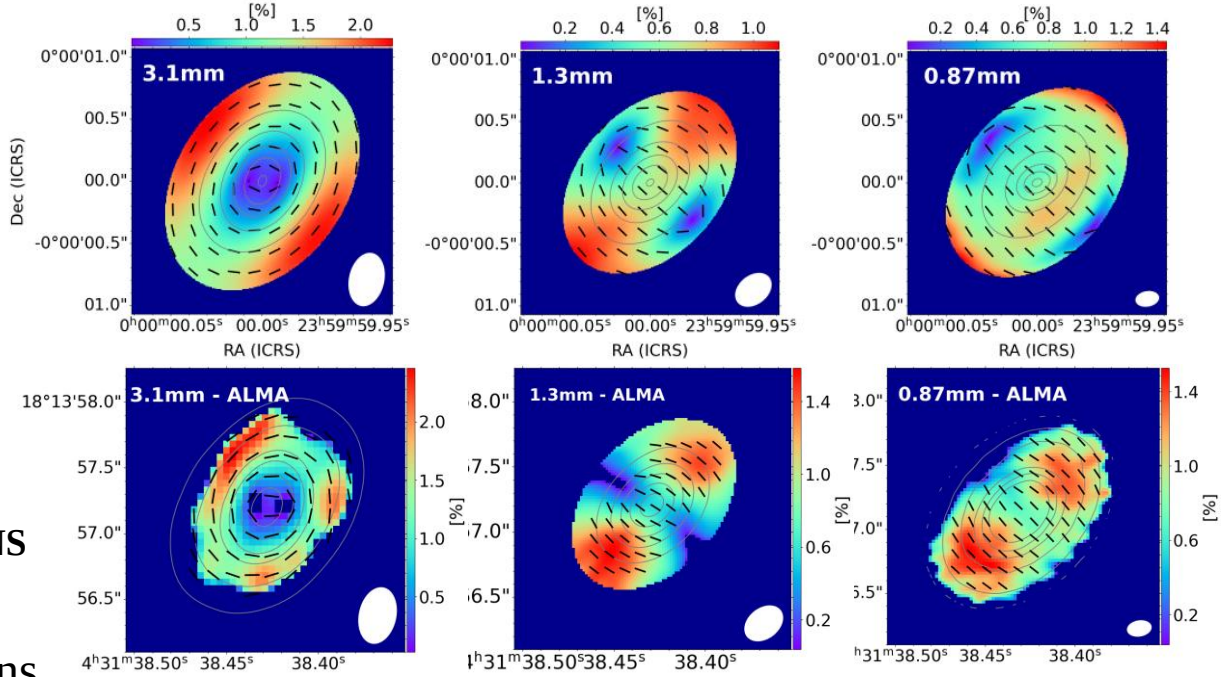
$T_{dust}>T_{disr}$: high T_{dust} and low $n(H_2)$

=> RATD => P(%) decreases as T_{dust} increases

Mixture Of MRAT Grain Alignment And Self-Scattering Models: HL Tau

OUR RESULTS

ALMA OBSERVATIONS

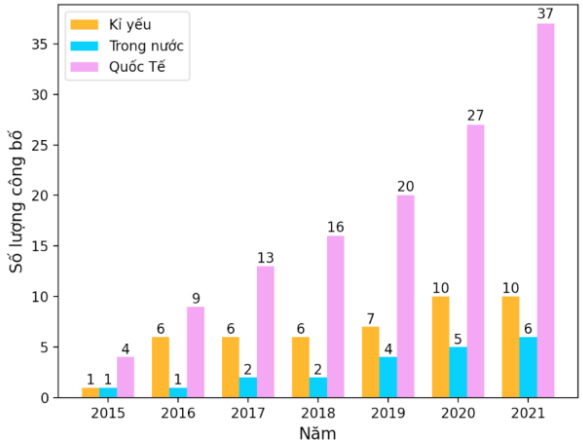


Nguyen Tat Thang in prep.

- Roughly reproduce observations
- Constrained results :
  - Grain size : $a_{max} \sim 130, 80, 60$ μm at $\lambda = 3.1, 1.3, 0.87$ mm
  - Grain magnetic property : $N_{cl} \sim 10^3$, $Q_{X,low\text{-}J} \sim -0.4$

Science and Training at DAP

Between **2015 and 2022** we have published 45 articles in international refereed journals.



Training

Undergraduate dissertations (13)

Master theses (20)

PhD Theses (8)

Interns (from Vietnam and abroad)

Summary

Astronomy and astrophysics in Vietnam are still in their infancy. We are making efforts to stimulate interest in the general public, to foster the teaching of basic knowledge, and to develop research on frontline topics.

Astrophysics, one of the most dynamic branches of modern physics, matches well our needs.

Open access data allow astronomers from developing countries to do frontier research. We are immensely indebted and grateful to this generous policy of the astronomical community, in particular the ALMA partnership.

We have been receiving constant support from abroad which is vital for our progress.

The sky belongs to all of us
We are all made of the same star dust.

Thank you for you attention!

Credit: Tran Ha