星形成セミナー

大橋聡史（理研）

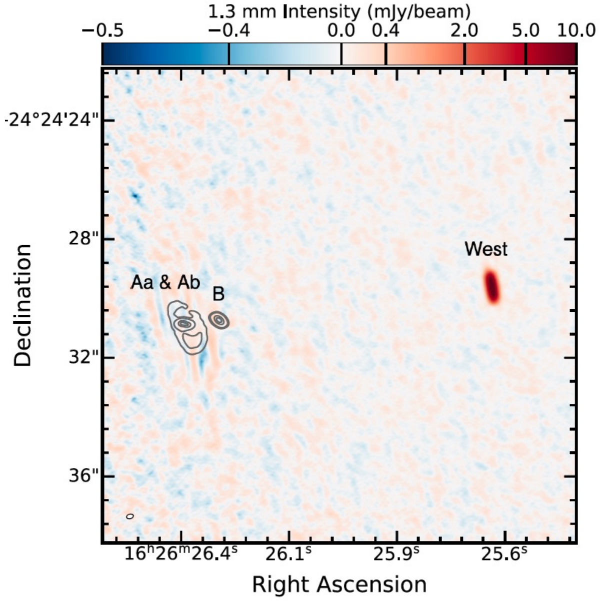
- Recent progress with observations and models to characterize the magnetic fields from star-forming cores to protostellar disks
- ArTéMiS imaging of the filamentary infrared dark clouds G1.75-0.08 and G11.36+0.80: Dust-based physical properties of the clouds and their clumps
- A millimeter-multiwavelength continuum study of VLA 1623 West
- Snapshot of a magnetohydrodynamic disk wind traced by water maser observations
- Could kilomasers pinpoint supermassive stars?
- Sequential Star Formation in the Young SMC Region NGC 602: Insights from ALMA
- Depletion of gaseous CO in protoplanetary disks by surface-energy-regulated ice formation
- Binding Energies of Interstellar Relevant S-bearing Species on Water Ice Mantles: A Quantum Mechanical Investigation
- Jet from the enigmatic high-latitude star BP Psc and evolutionary status of its driving source

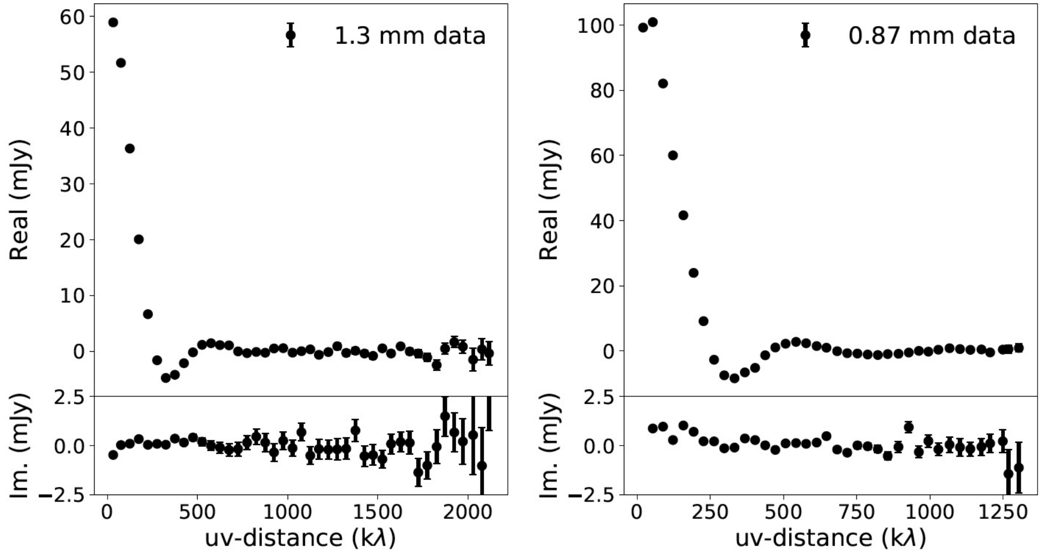
A millimeter-multiwavelength continuum study of VLA 1623 West

Arnaud Michel[1], Sarah I. Sadavoy[1], Patrick D. Sheehan[2], Leslie W. Looney[3] and Erin G. Cox[2]

VLA 1623領域のsource Wに着目し、円盤の構造をuv planeとimageで調べた

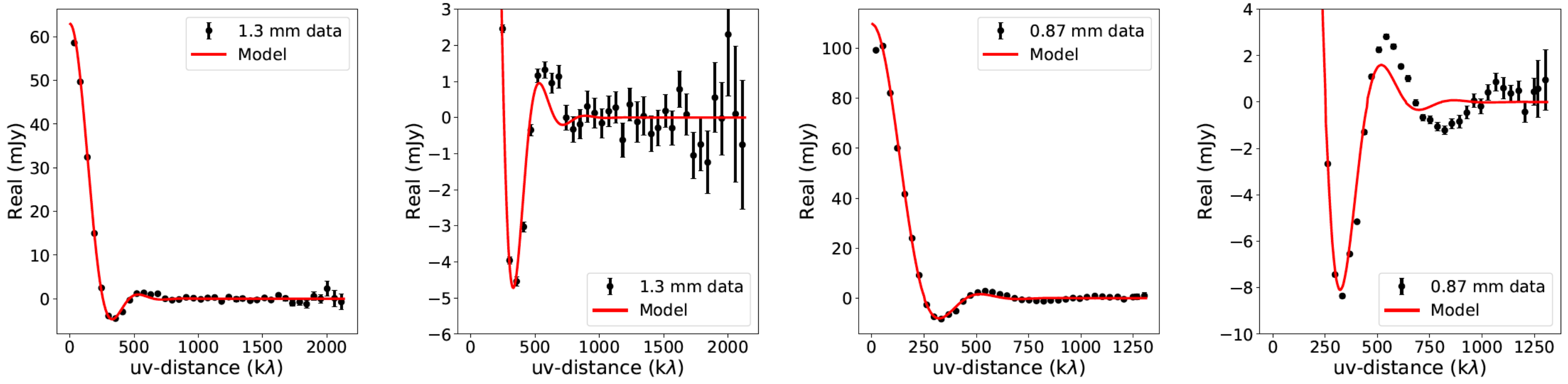
ALMAの0.87 & 1.3 mmのデータ
（本来はVLA 1623 ABの偏光観測が目的だった）





結論
Source Wは中心がsaturationしている円盤構造で説明できる
Edge-on構造なので垂直方向の沈殿も調べたが、かなりフレアしている

Flat-Topped Gaussian model

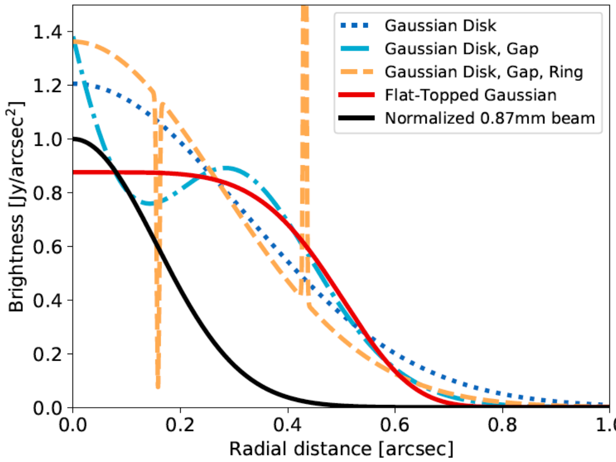


A millimeter-multiwavelength continuum study of VLA 1623 West

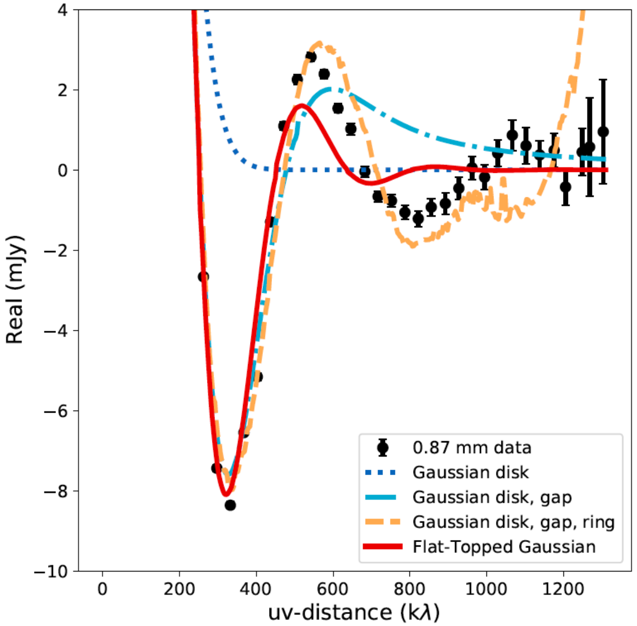
Arnaud Michel,[1] Sarah I. Sadavoy,[1] Patrick D. Sheehan,[2] Leslie W. Looney,[3] and Erin G. Cox[2]

内側の強度分布がフラットな円盤がよく合う

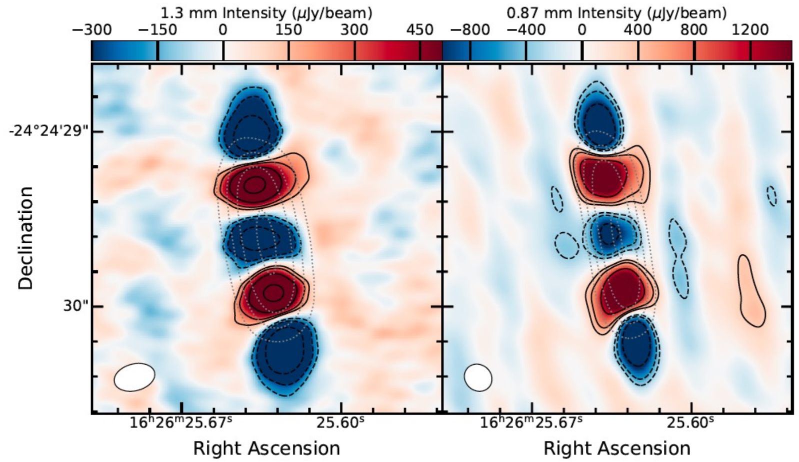
Intensity fits



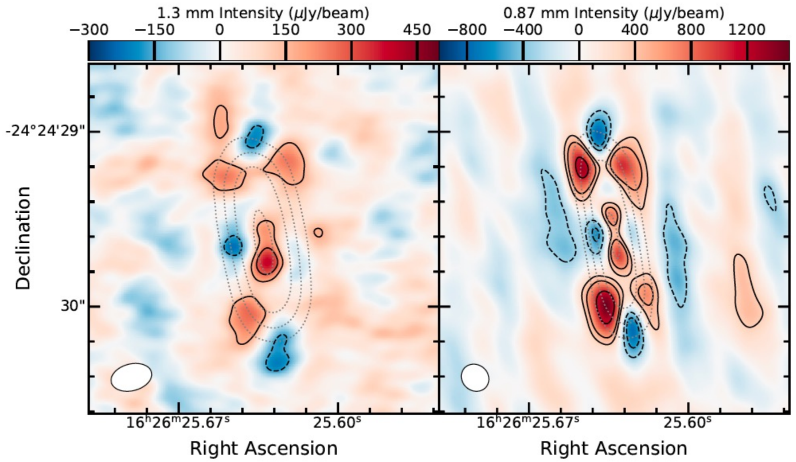
***uv* profiles**



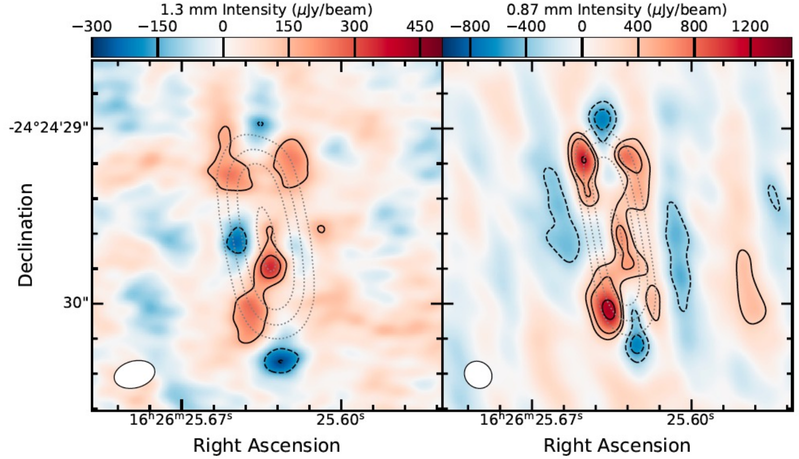
Gaussian disk residuals



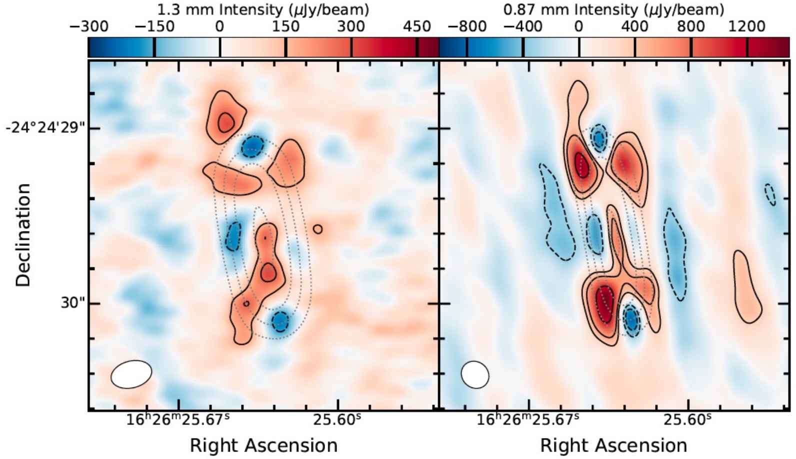
Gaussian disk, gap residuals



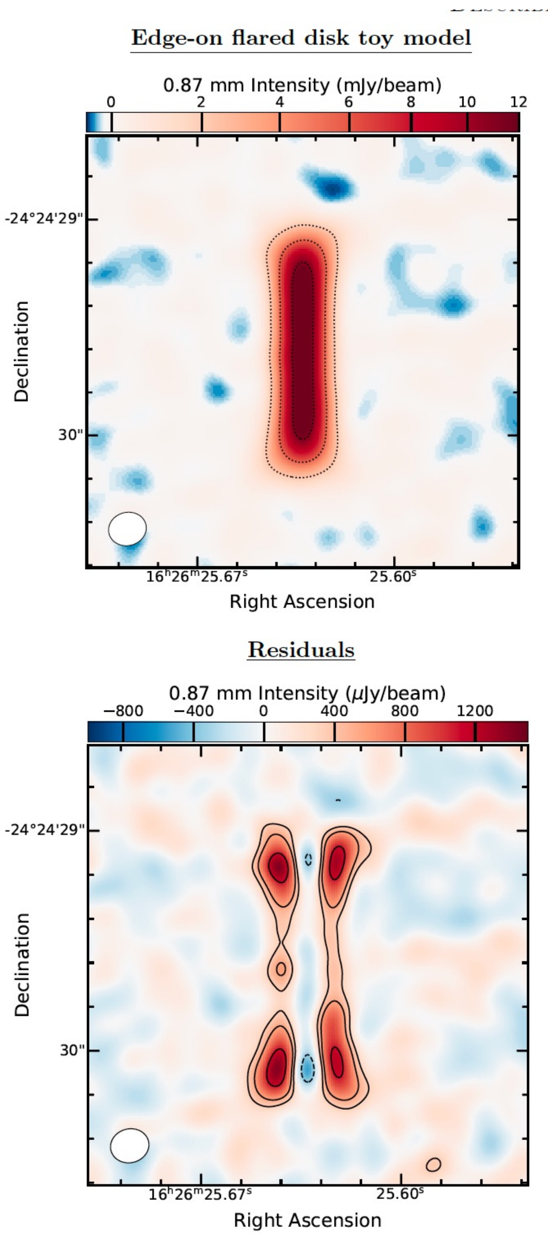
Gaussian disk, gap, ring residuals



Flat-Topped Gaussian residuals

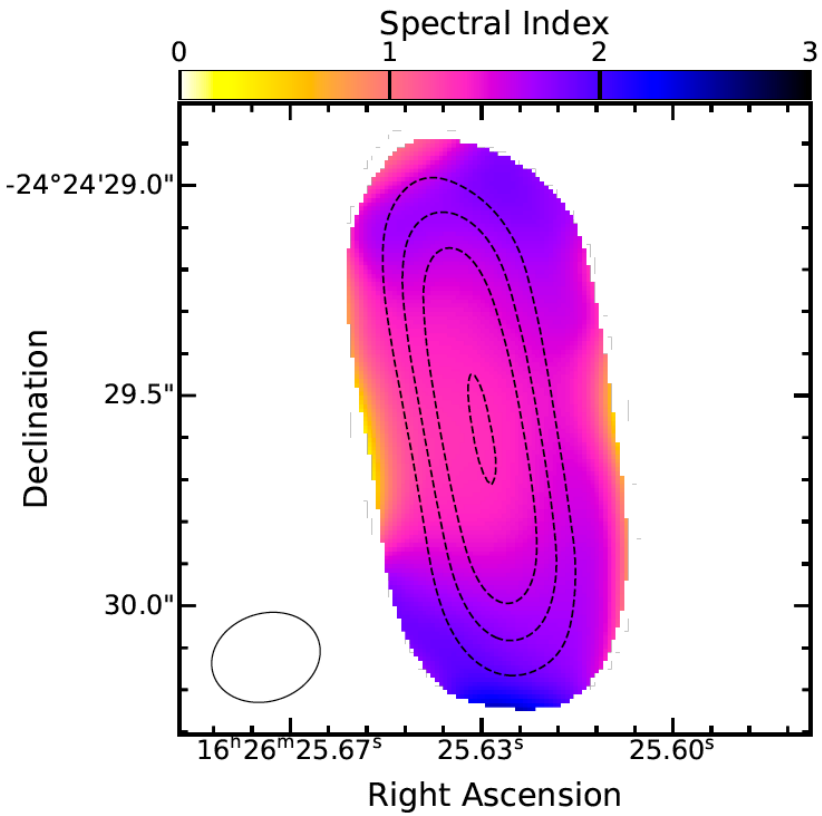


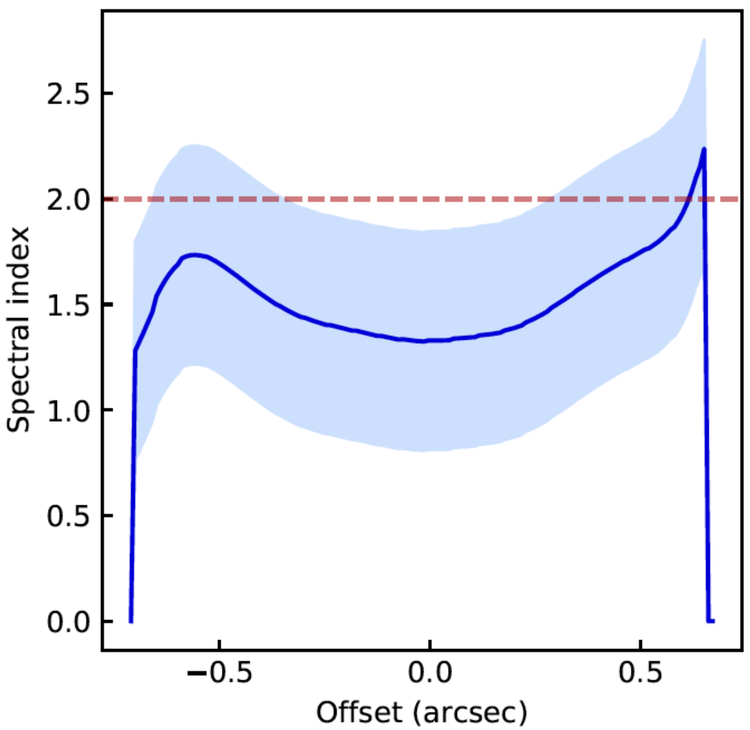
A millimeter-multiwavelength continuum study of VLA 1623 West



- 円盤に構造は見られない（光学的に厚いだけかも）
- スペクトラル　インデックスはα<2
- 円盤はedge-on構造をしているし、外側でフレアしている
    - → inclination (80度）の問題では無さそう

Class 0の円盤はダスト沈殿がまだしていない
※L1527円盤(Class 0/I)も同じ結果(Ohashi+22)





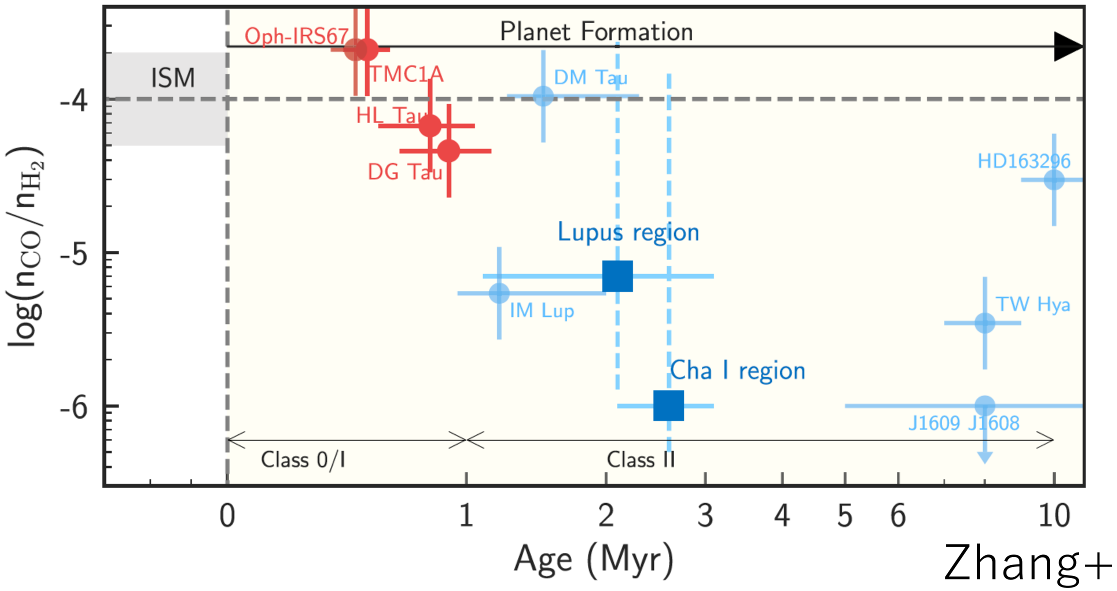
Depletion of Gaseous CO in Protoplanetary Disks by Surface Energy Regulated Ice Formation

Nature Astronomy

Authors: Diana Powell[1,2,*], Peter Gao[3], Ruth Murray-Clay[4], Xi Zhang[5]

Empirical constraints of fundamental properties of protoplanetary disks are essential for understanding planet formation and planetary properties1, 2. Carbon monoxide (CO) gas is often used to constrain disk properties3. However, estimates show that the CO gas abundance in disks is depleted relative to expected values4-7, and models of various disk processes impacting the CO abundance could not explain this depletion on observed ~1 Myr timescales8-14. Here we demonstrate that surface energy effects on particles in disks, such as the Kelvin effect, that arise when ice heterogeneously nucleates onto an existing particle, can efficiently trap CO in its ice phase. In previous ice formation models, CO gas was released when small ice-coated particle where lofted to warmed disk layers. Our model can reproduce the observed abundance, distribution, and time evolution of gaseous CO in the four most studied protoplanetary disks7. We constrain the solid and gaseous CO inventory at the midplane and disk diffusivities and resolve inconsistencies in estimates of the disk mass—three crucial parameters that control planetary formation.

COガスの観測から円盤のガス質量を測定しているが、COの存在度は時間進化で減少する



Zhang+20

この観測結果を説明するため、ダスト表面でのケルビン効果を考慮した。CO iceが大きなダストにより沢山吸着して、円盤に沈殿させることでCO depletionを再現
TW Hya, HD 163296, IM Lup, DM Tauの結果と一致

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ケルビン効果
液表面の曲率が液表面蒸気圧を変化させる効果をいう。液滴のように凸の表面では平らな表面の蒸気圧よりも上昇し，一方，細孔内の液表面のように凹な表面では逆に低下する。また，その上昇または低下の度合いは，表面の曲率が小さいほど大きい。

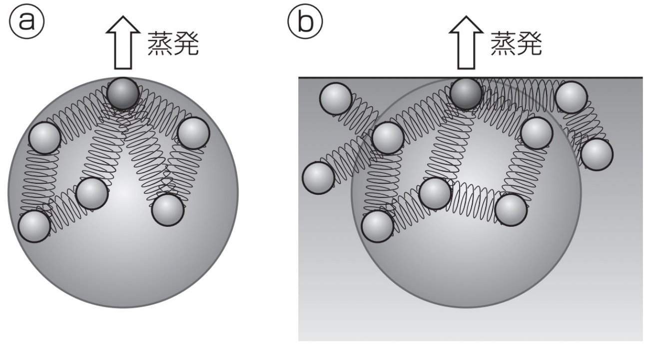
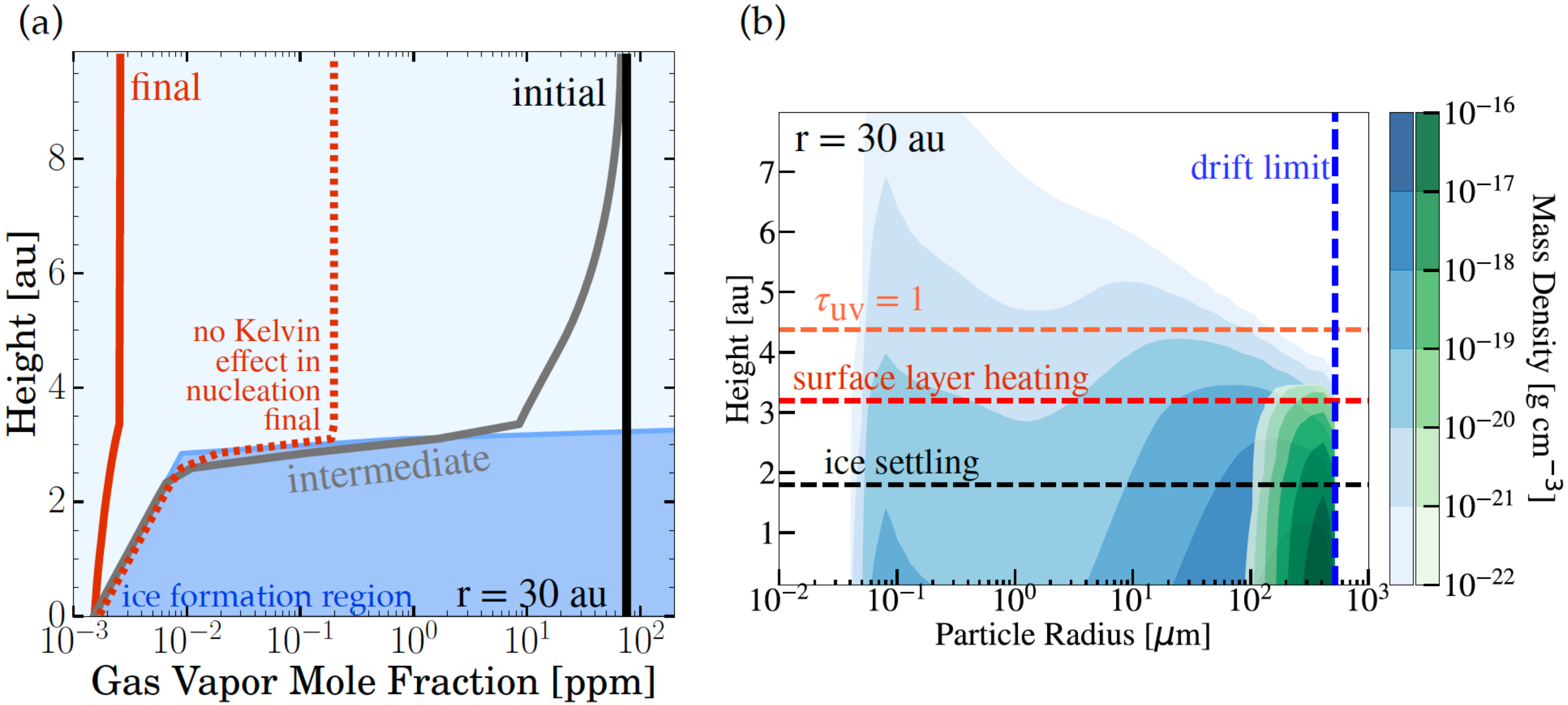


図 1　液体の水の中での分子間力が水の蒸発を妨げる様子を表す概念図。小さな水滴(ⓐ)では平らな水面(ⓑ)に比べて少しの分子しか関与しないため，蒸発が起こりやすい。そのため，小さい水滴ほど平衡相対湿度が大きい，言い換えると凝縮しにくいといえる。

ダストが小さいと蒸発しやすい（吸着しにくい）が
大きなダストはより吸着しやすく、COがより豊富になる

大きなダストに沢山COを付着させて、円盤の中央面に
沈殿させておけばCOのガスはdepletionさせられる

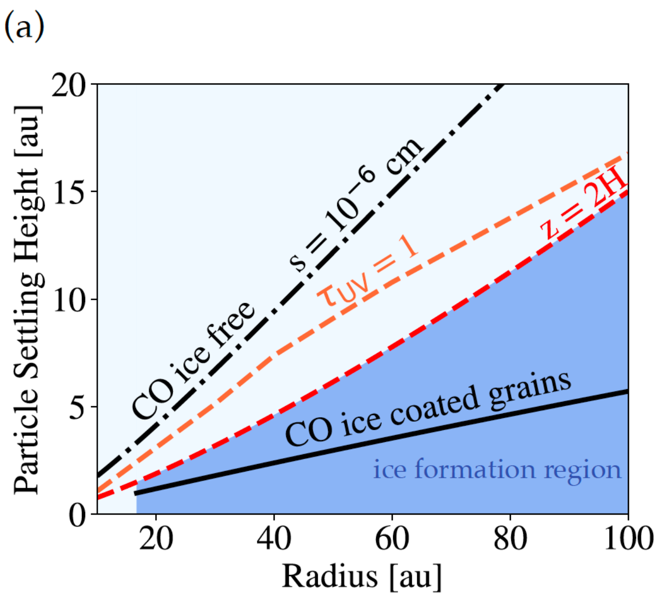
Depletion of Gaseous CO in Protoplanetary Disks by Surface Energy Regulated Ice Formation

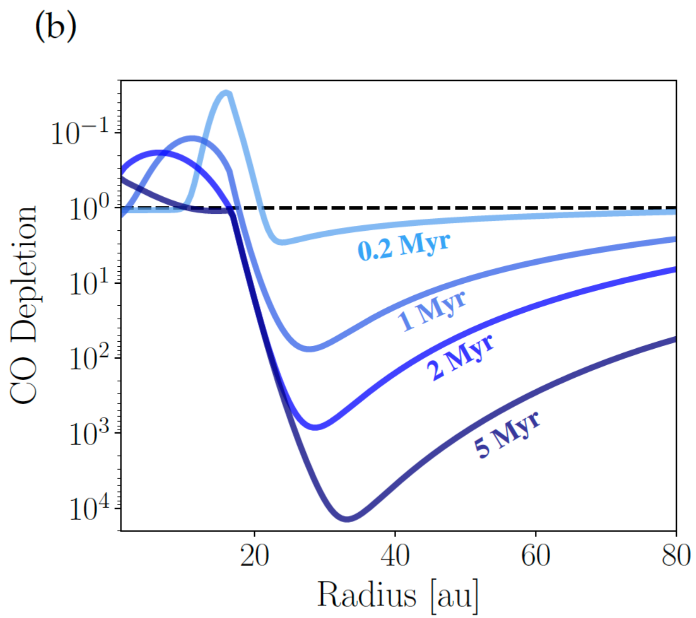


(a) ケルビン効果がないと、小さなダストにもCOが付着する
→ 小さなダストは円盤の表層へと巻き上がりガスへと脱着するのでCOガスの存在度は高くなる

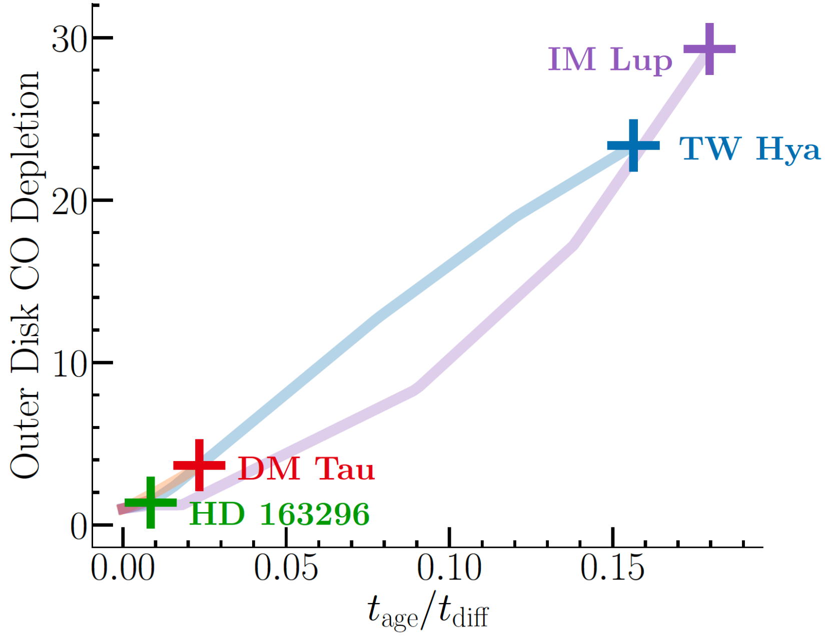
(b) 大きなダストにCOが選択的に付着しダスト成長する(radial driftでlimit)
→ 円盤上層はCO iceがないダストしかいないのでCO depletionの観測を説明できる

Depletion of Gaseous CO in Protoplanetary Disks by Surface Energy Regulated Ice Formation



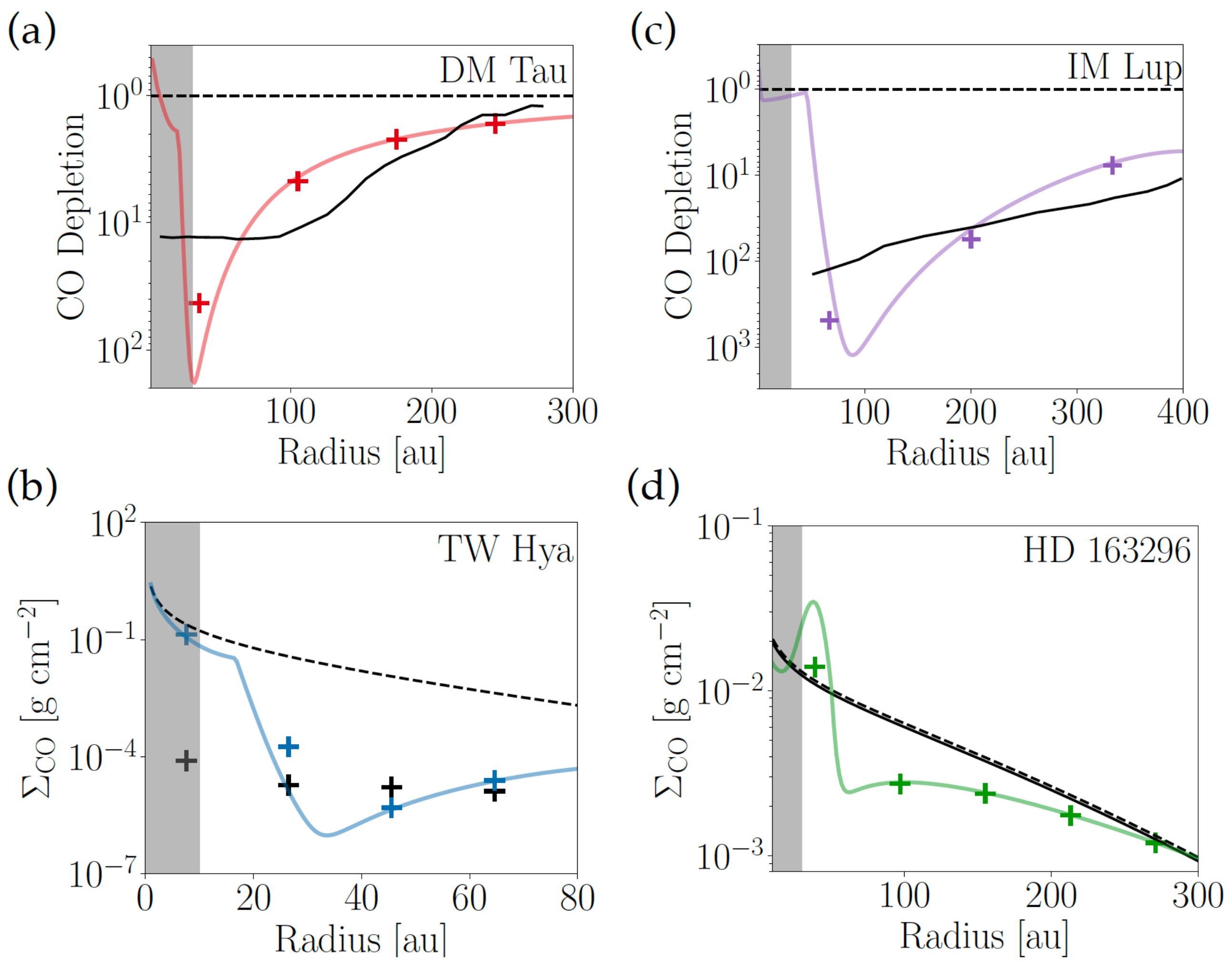


$$t_{\mathrm{diff}} = r_{\mathrm{out}}^2/\alpha c_s H$$



Disk	Disk Mass [$M_\odot$]	α	Accreted CO Mass [%]	Inner CO Gas Mass [%]	Outer CO Gas Mass [%]	CO Ice Mass (outer disk) [%]
TW Hya	0.11 ([20,21])	8×10^{-4}	51	47	2	<1
HD 163296	0.21 ([20])	10^{-4}	4	16	62	18
DM Tau	0.05 ([22])	3×10^{-3}	14	12	24	50
IM Lup	0.10 (see methods)	1.5×10^{-2}	69	17	2	12

Depletion of Gaseous CO in Protoplanetary Disks by Surface Energy Regulated Ice Formation



表面エネルギー制御による氷生成は、観測された様々な円盤のCOガス量を説明することができる。それぞれの系について、モデルの結果（ビームサイズに応じた値を色つきの線と十字）と観測文献で報告されている量（黒い実線または十字）との比較。文献で報告されている量は、CO表面密度またはCO枯渇量であり、報告量と一致するように結果。また、初期のCOガス分布も示している（黒破線）。灰色斜線の領域は光学的に厚いと思われる。

Jet from the enigmatic high-latitude star BP Psc and evolutionary status of its driving source.

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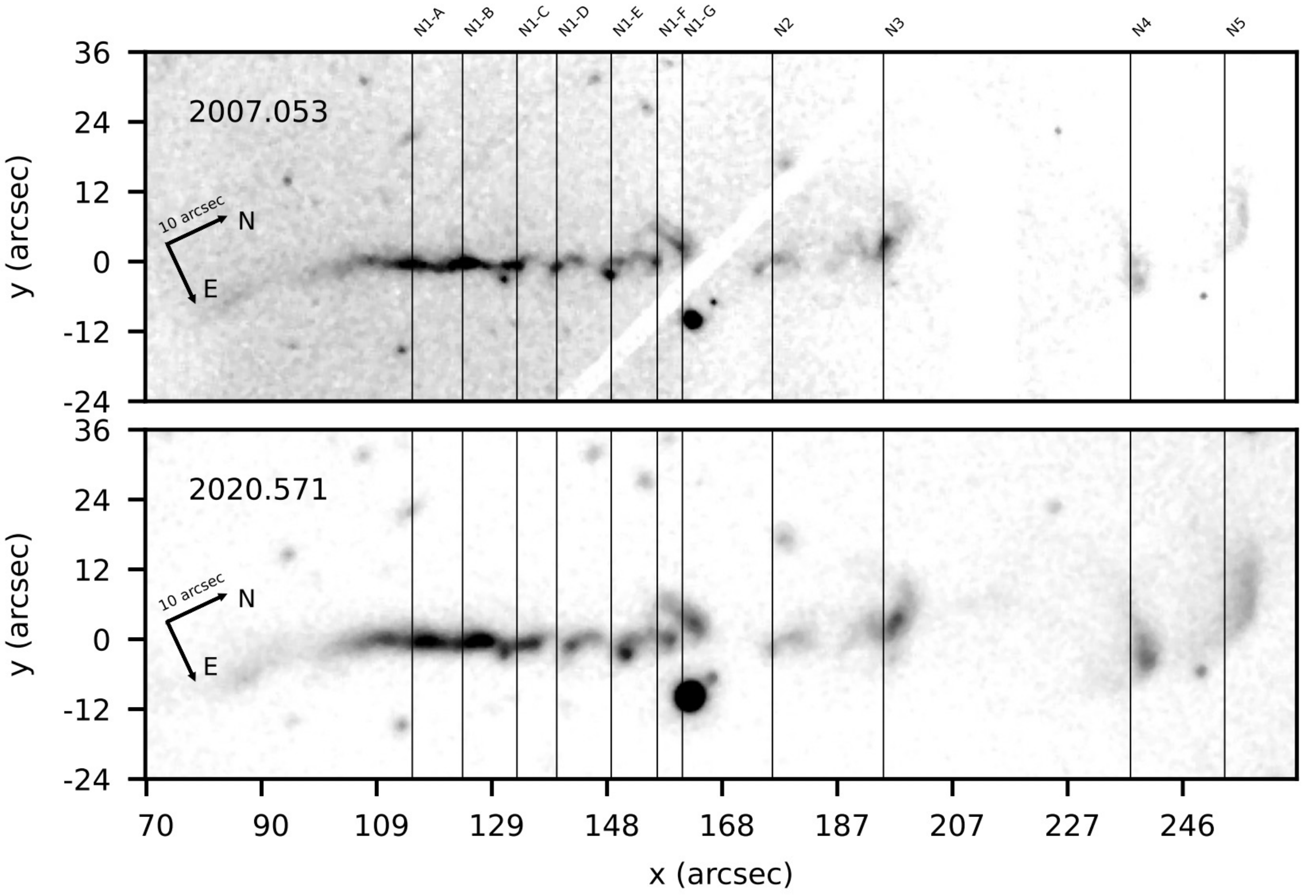
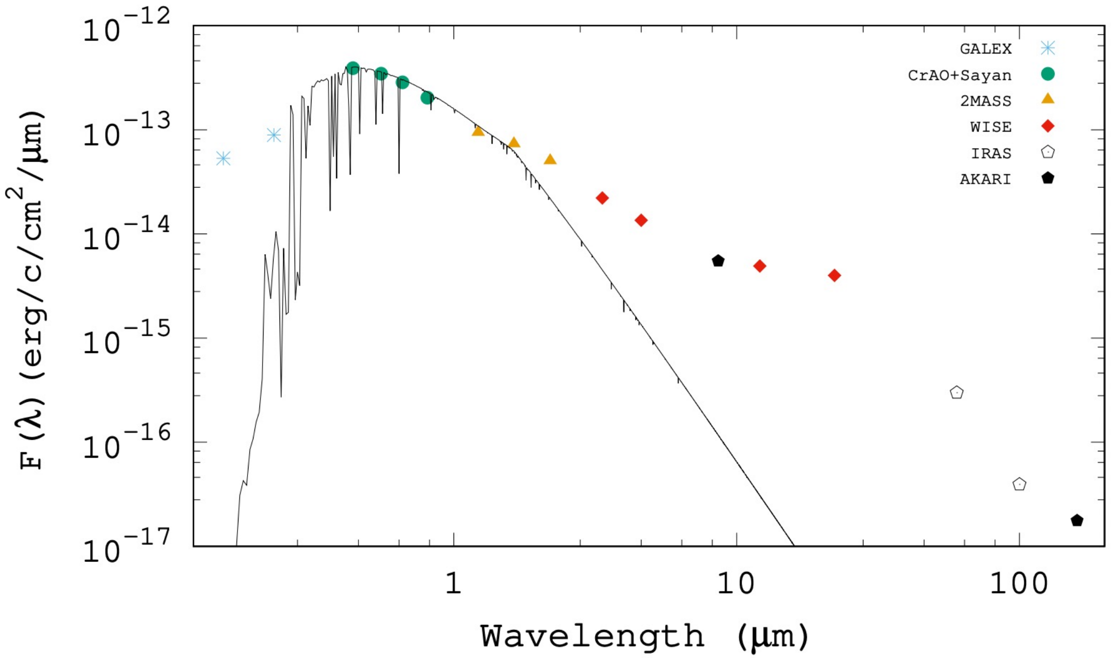
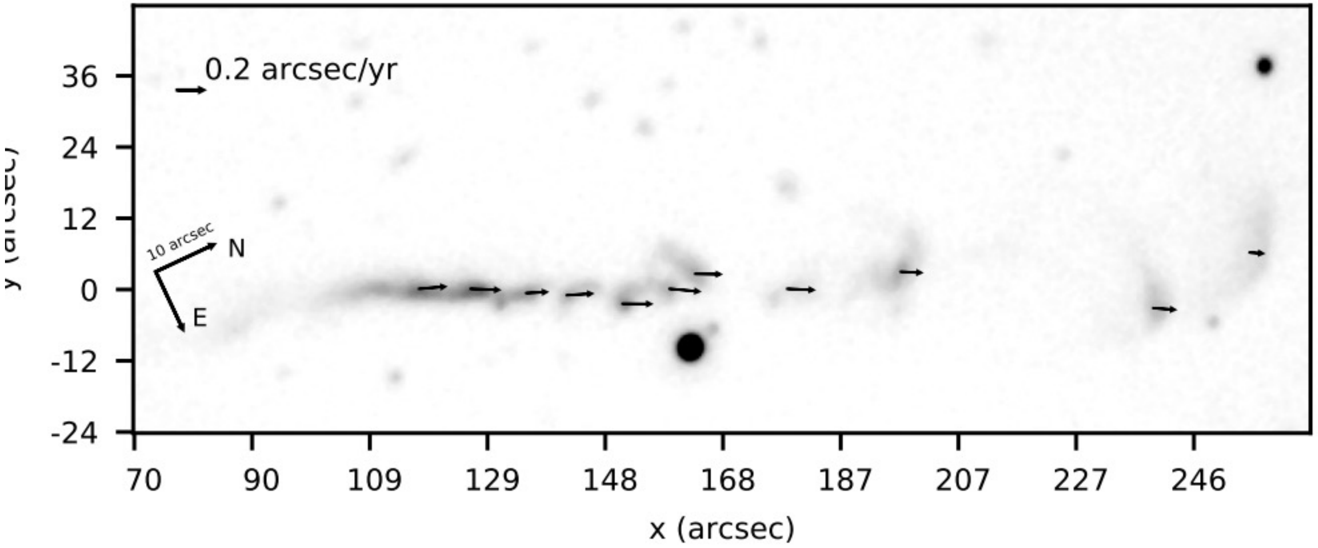
ABSTRACT

BP Psc is an active late-type (sp:G9) star with unclear evolutionary status lying at high galactic latitude $b = -57°$. It is also the source of the well collimated bipolar jet. We present results of the proper motion and radial velocity study of BP Psc outflow based on the archival $H\alpha$ imaging with the GMOS camera at 8.1-m Gemini-North telescope as well as recent imaging and long-slit spectroscopy with the SCORPIO multi-mode focal reducer at 6-m BTA telescope of SAO RAS. The 3D kinematics of the jet revealed the full spatial velocity up to $\sim$140 km$\cdot$s^{-1} and allows us to estimate the distance to BP Psc system as $D = 135 \pm 40$ pc. This distance leads to an estimation of the central source luminosity $L_* \approx 1.2 L_\odot$, indicating that it is the $\approx 1.3 M_\odot$ T Tauri star with an age $t \lesssim 7$ Myr. We measured the electron density of order $N_e \sim 10^2$ cm^{-3} and mean ionization fraction $f \approx 0.04$ within the jet knots and estimated upper limit of the mass-loss rate in NE lobe as $\dot{M}_{out} \approx 1.2 \cdot 10^{-8} M_\odot \cdot yr^{-1}$. The physical characteristics of the outflow are typical for the low-excitation YSO jets and consistent with the magnetocentrifugal mechanism of its launching and collimation. Prominent wiggling pattern revealed in $H\alpha$ images allowed us to suppose the existence of a secondary substellar companion in a non-coplanar orbit and estimate its most plausible mass as $M_p \approx 30 M_{Jup}$. We conclude that BP Psc is one of the closest to the Sun young jet-driving systems and its origin is possibly related to the episode of star formation triggered by expanding supershells in Second Galactic quadrant.


N1-A
N1-B
N1-C
N1-D
N1-E
N1-F
N1-G
N2
N3
N4
N5
2007.053
2020.571
10 arcsec
N
E
y (arcsec)
x (arcsec)
36
24
12
0
-12
-24
70
90
109
129
148
168
187
207
227
246


GALEX
CrAO+Sayan
2MASS
WISE
IRAS
AKARI
10^{-12}
10^{-13}
10^{-14}
10^{-15}
10^{-16}
10^{-17}
F(λ) (erg/c/cm^2/μm)
1
10
100
Wavelength (μm)

Teff = 5100 K


0.2 arcsec/yr
10 arcsec
N
E
36
24
12
0
-12
-24
70
90
109
129
148
168
187
207
227
246
x (arcsec)