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1. Herschel observations of EXtra-Ordinary Sources: Analysis of the HIFI 1.2 THz Wide Spectral Survey Toward Orion KL II. Chemical Implications

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Herschel observations of EXtra-Ordinary Sources: Analysis of the HIFI 1.2 THz Wide Spectral Survey Toward Orion KL II. Chemical Implications

N.R. Crockett et al.

- ホットコアのcomplex mol.の生成過程について調査
- Orion KL
    - ホットコア
    - compact ridge
    - plateau (outflow)
- Herschel/HIFI HEXOS program
    - Crockett+2014(Paper1)のラインサーベイ結果を使用
        - 分解能11-44″
    - complex mol.に着目した解析
    - XCLASSによるモデリング

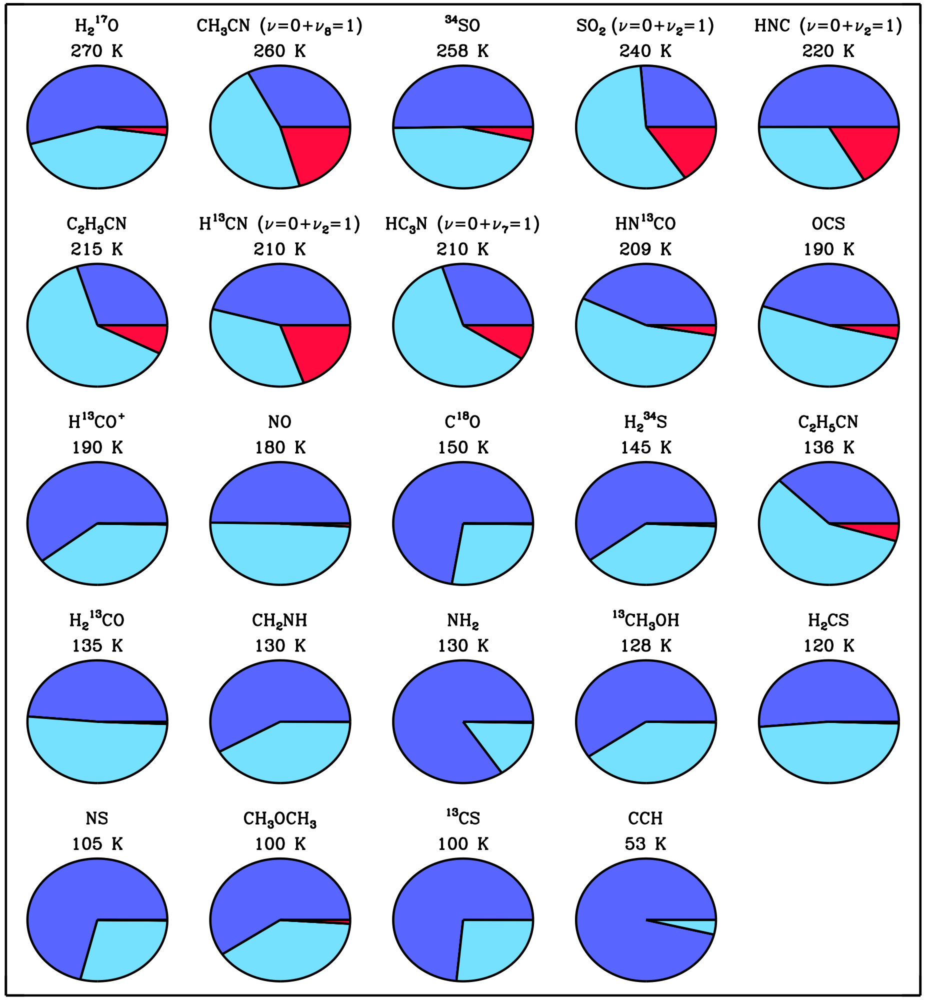
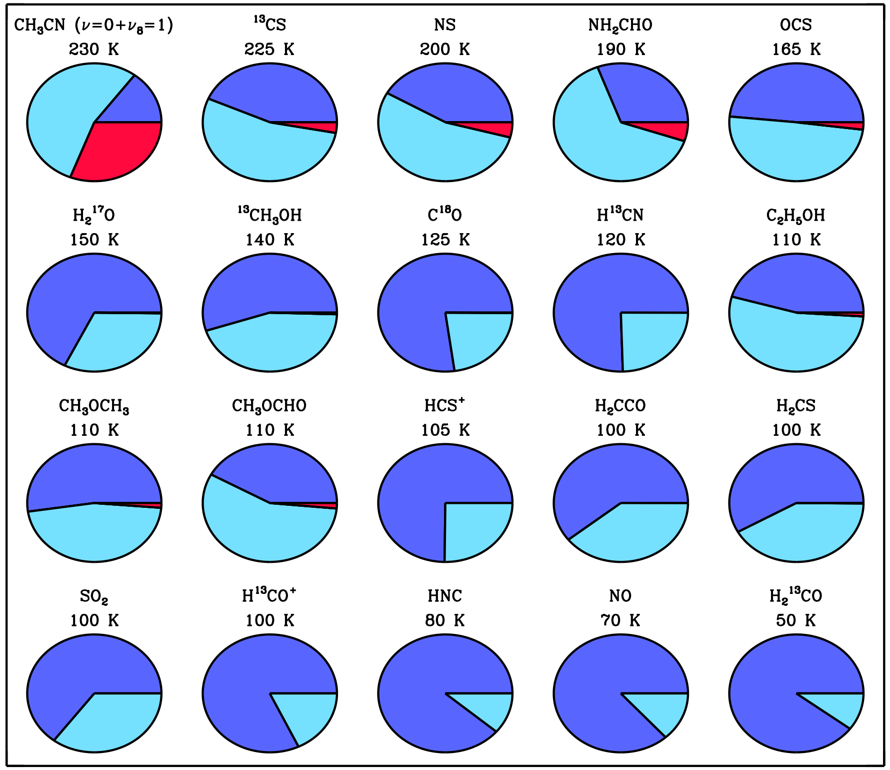
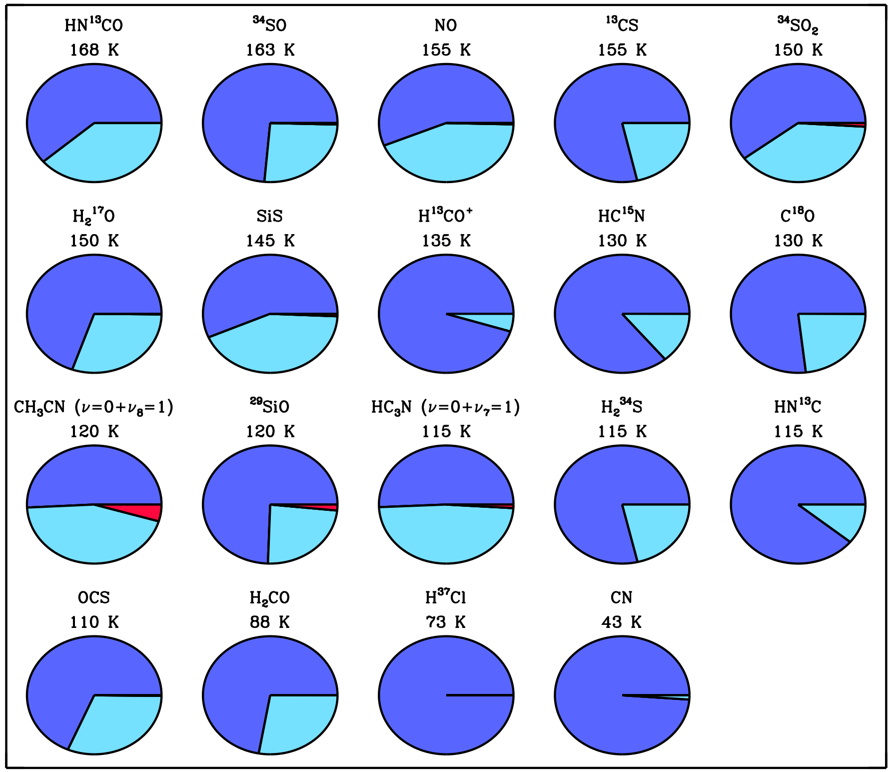


Fig. 1.— Pie charts that plot the fraction of total integrated intensity originating from states in E_{up} ranges 0 – 200 K (dark blue), 200 – 800 K (cyan), and 800 – 3000 K (red) for molecules detected toward the hot core. The molecule ID and T_{rot} derived in Paper I are given above each chart. If a chart includes emission from a vibrationally excited state, it is indicated in parentheses with the molecule ID.

検出した輝線に対し、その輝線の全積分強度が占める割合をEupで色分けしたもの

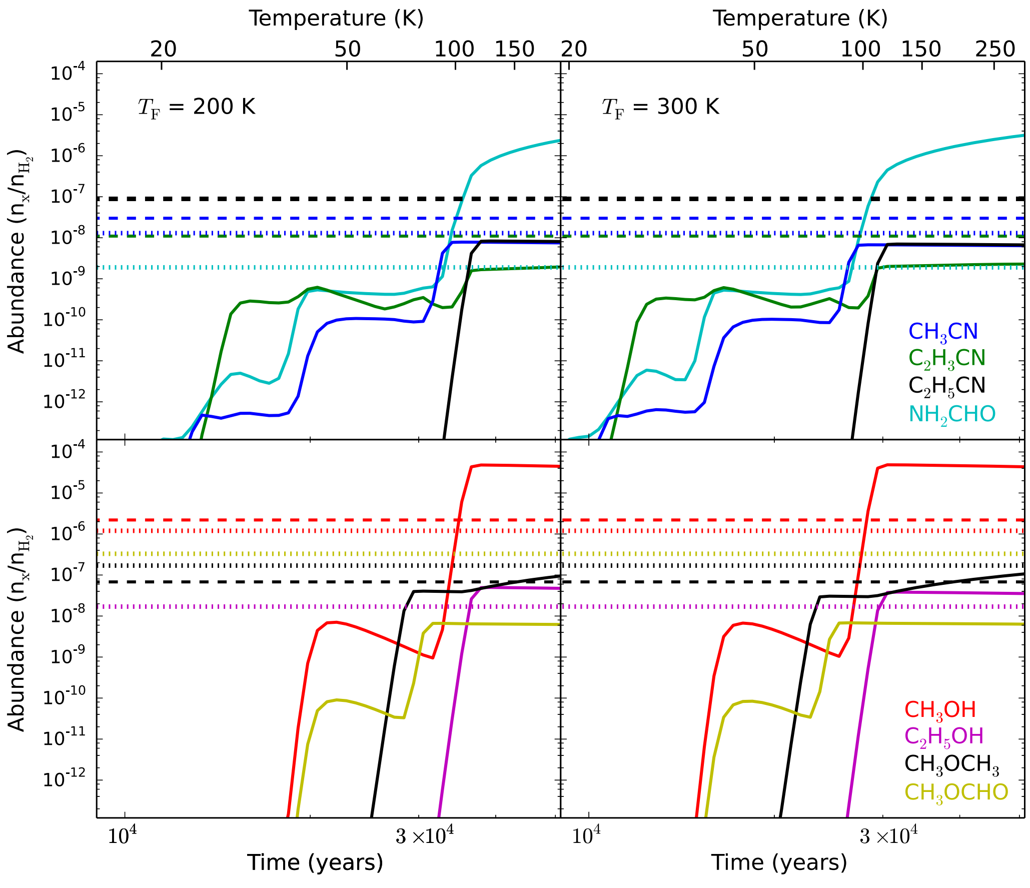
- Hot core
  - 5つのcomplex mol.
    - CNを含むものはhighly excited
  - シンプルなCN系分子もhighly excited
- compact ridge
  - hot coreと似た傾向
  - N系がhighly excited
- plateau
  - CH_3CNが唯一のhighly excited spectrum
- S+O系の分子もhottest gasのトレーサーかも



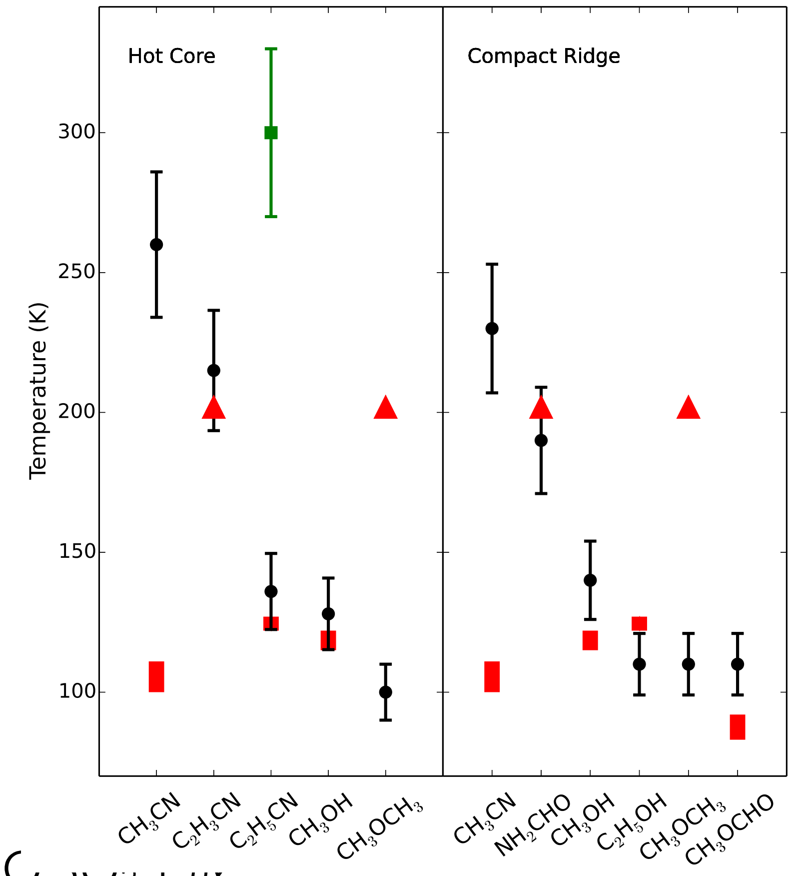


- OSU gas-chemicalコードを使用して化学モデリング
- 物理構造進化は追わない
  - コードの確認とN系分子の傾向と再現に着目
- 二つのphaseでアバンダンス進化を計算
  - isothermal collapse
    - 10K, 1Myr
  - warm-up phase
    - 温度がt_{warm}で上昇し最終温度T_F
    - t_{warm}とT_Fを変えて計算

warm-up phaseで予想されるabundance



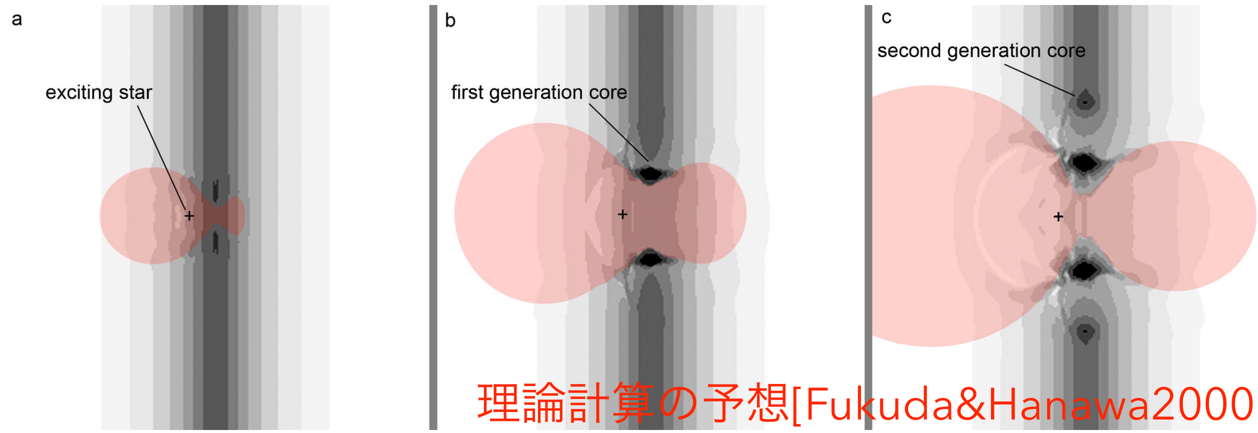
- N系分子は高温をトレース(Oより)
  - N系はダストから蒸発しづらい
    - N,Oの比較はTexの高分解能観測が必要
  - ガスフェーズ反応でhighly excited cyanideを作る
    - 高温でCH_3CN等を生成するモデルあり [Rodgers&Charnley2001など]



- S+Oも高温をトレース
  - H_2S生成(ダスト上)->evaporation->ガスフェーズでSO,SO_2生成
- 化学モデル(OSU)との比較
  - 観測のT_{rot}とモデルのT_{max}を比較 [Carrod+2008]
    - 基本的にはよく合う
  - モデルから予想される年齢は>10^5 yrであり、これまでの予想より長い(10^{3-4}yr)
    - 物理構造にも依存するのでrobustではない

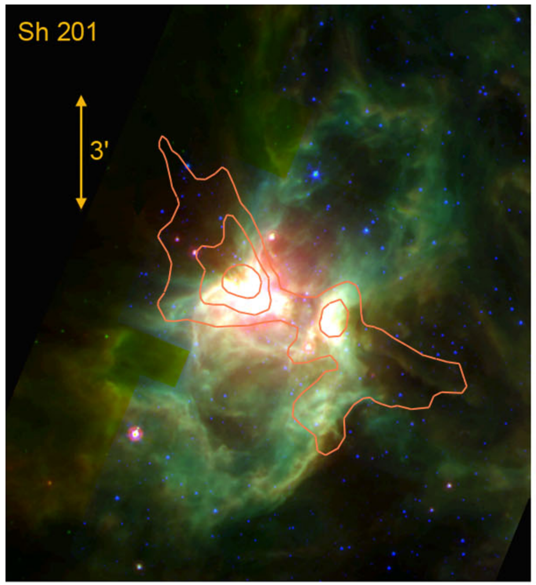
Bipolar HII regions - Morphology and star formation in their vicinity I - G319.88+00.79 and G010.32-00.15
L. Deharveng, et al.

- ISMフィラメントで見られるHII bipolar nebula(バブル構造)の探査
    - シリーズ物の紹介論文
    - 検出された16個のうち二つの領域に着目
- 使用する観測データ
    - DSS, Spitzer GLIMPSE, Herschel Hi-GAL, 2MASS, MALT90
- シミュレーションを元に見えうる構造を予想
    - dense filament
    - HII region - filamentに垂直
    - HII regionの励起星
    - bipolar nebularによってはかれたdense material



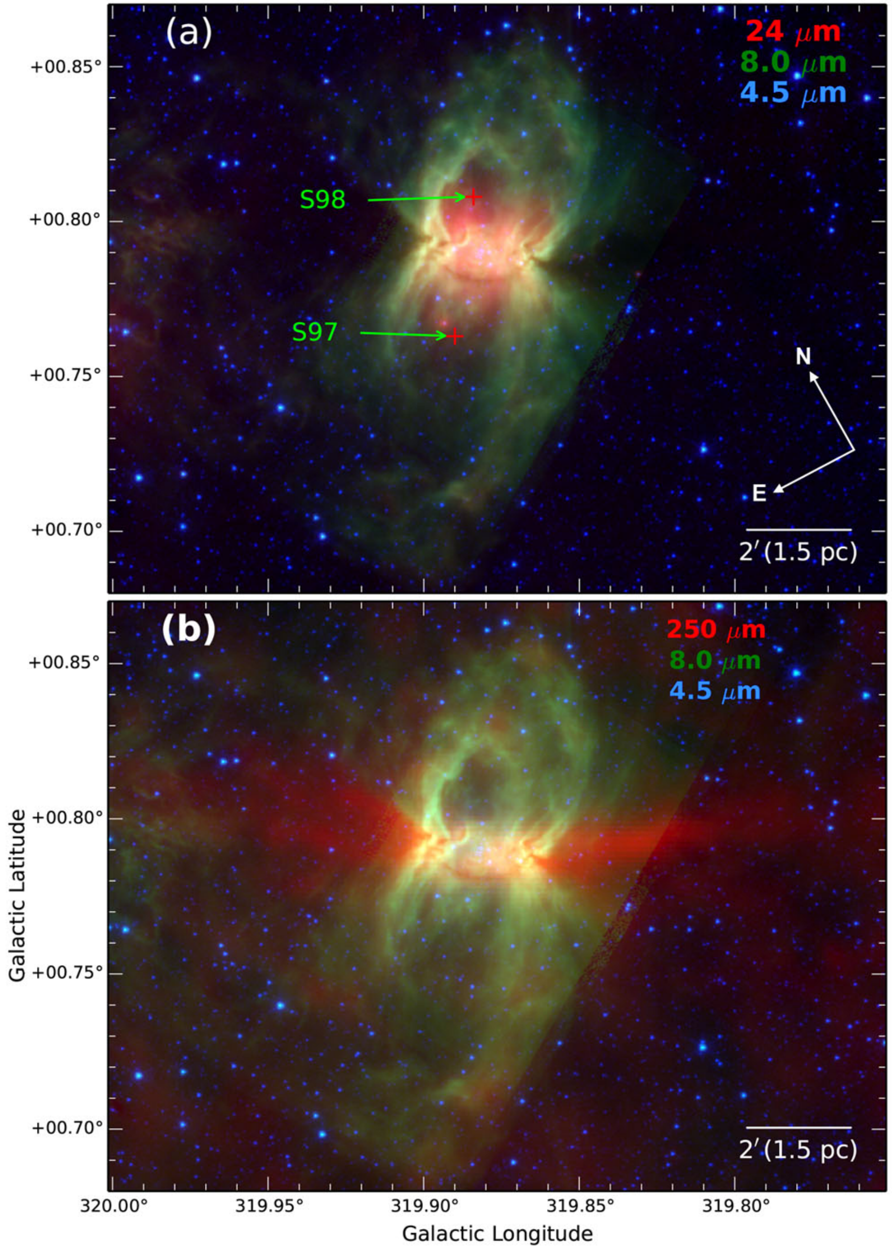
理論計算の予想[Fukuda&Hanawa2000]

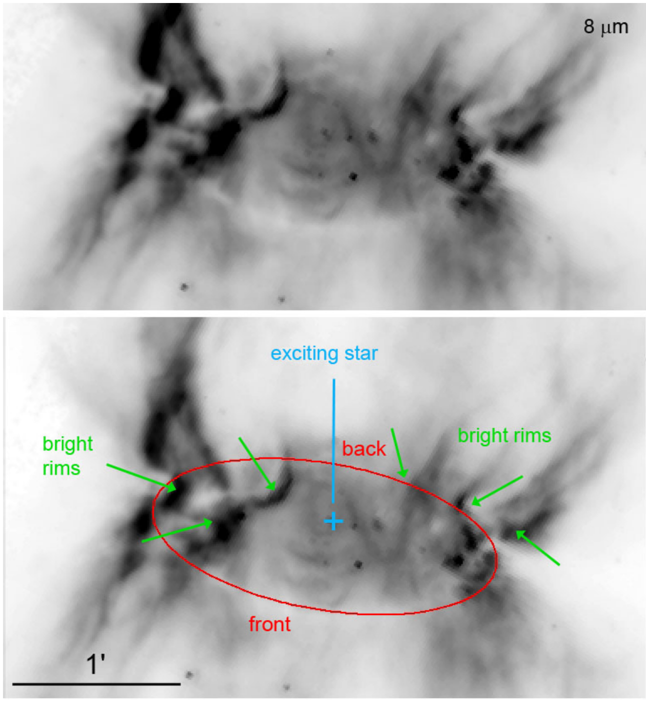
良い観測結果例

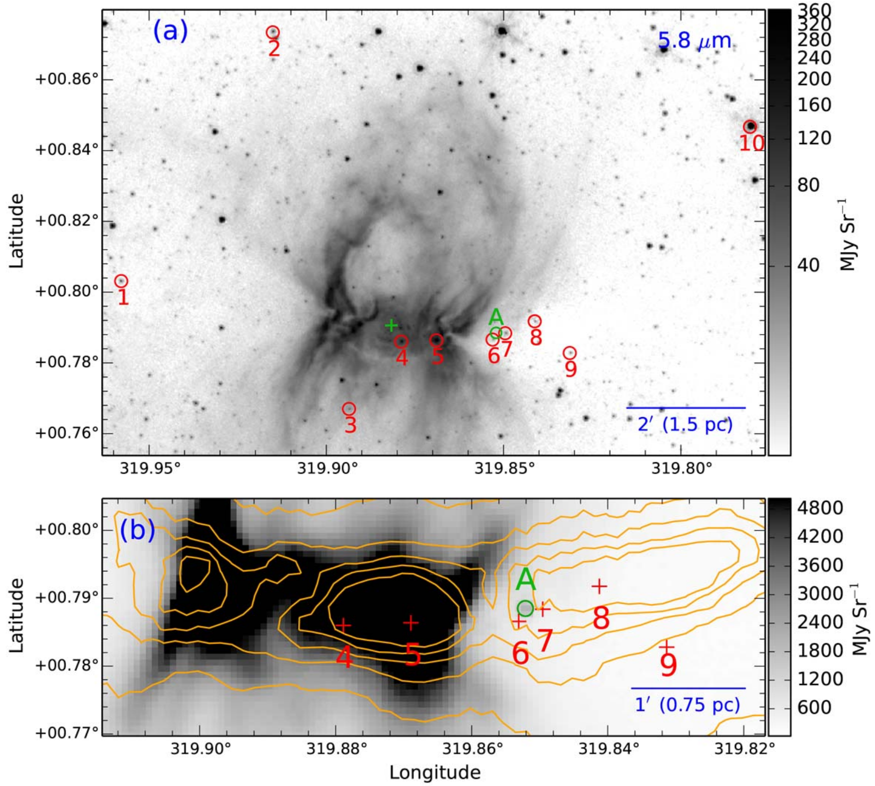


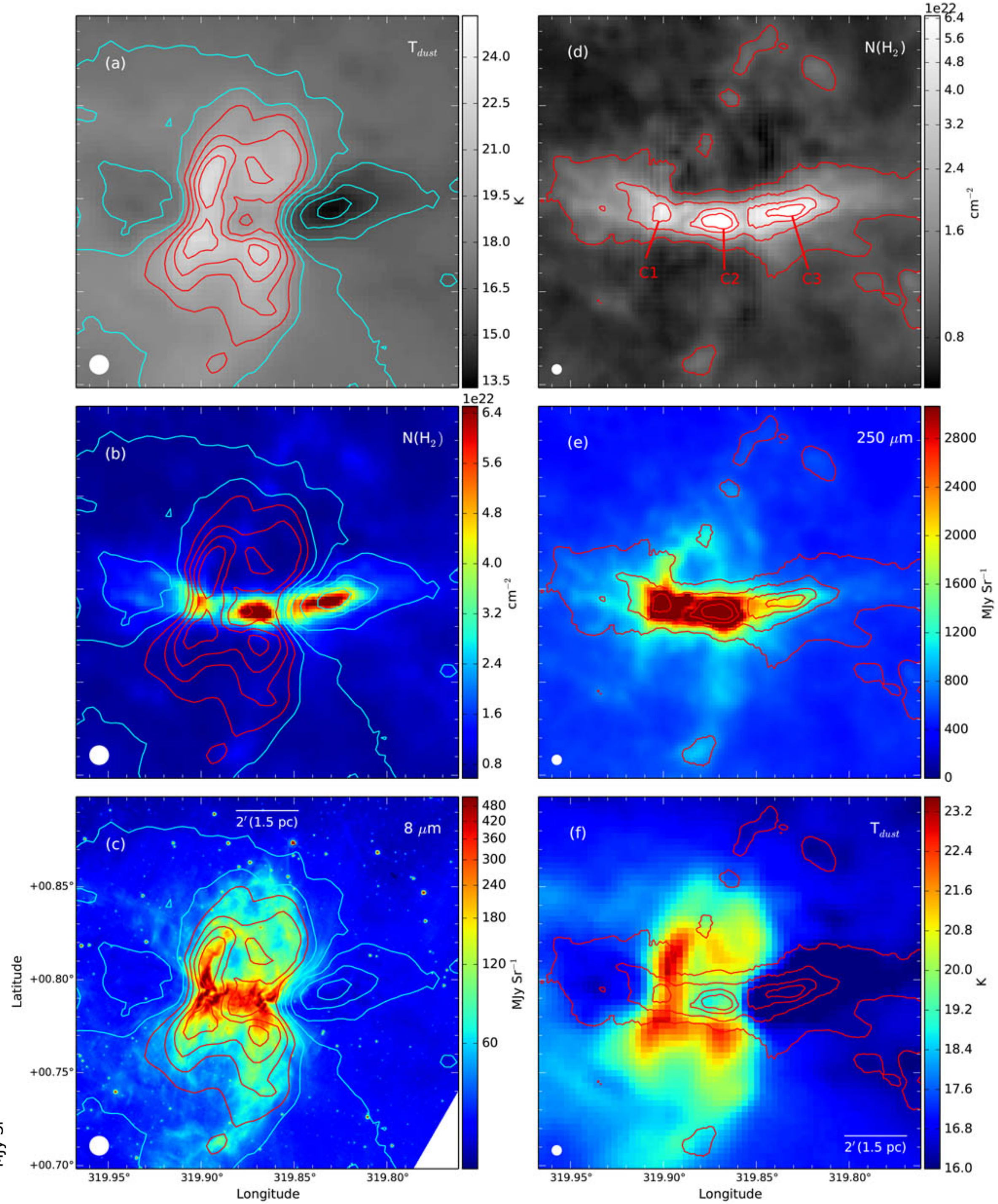
- Reduction methodの紹介
  - Tdust、柱密度および質量の導出 - Herschel
  - clumpの速度構造 - MALT90の分子輝線
  - YSO同定 - Spitzerのcolor-colorおよびa

- G319.88-00.79の結果の紹介
  - bipolar成分がIRで見え、それに垂直にフィラメントが伸びる
  - 中心付近ではリング状分布
    - 手前側の減光が大きい
  - TdustはフィラメントでTcold(13.6K)、HIIバブル付近で23.2K
  - $N(H_2)$マップで3つのclump
  - YSOの同定 - #4-9は付随するYSO




8 μm
exciting star
bright rims
back
bright rims
front
1'


(a)
5.8 μm
Latitude
Mjy Sr^{-1}
2′ (1.5 pc)
A
(b)
Latitude
Longitude
Mjy Sr^{-1}
1′ (0.75 pc)


(a)
T_{dust}
K
(d)
$N(H_2)$
1e22
cm^{-2}
C1
C2
C3
(b)
$N(H_2)$
1e22
cm^{-2}
(e)
250 μm
MJy Sr^{-1}
(c)
8 μm
2′(1.5 pc)
MJy Sr^{-1}
Latitude
Longitude
(f)
T_{dust}
K
2′(1.5 pc)
Longitude

- IRDCとの関連
  - 観測領域でIDされてるIRDCは必ずしも高密度領域にない
- global morphology
  - 南側の手前にcoldなガスが存在
    ->リングの下側の吸収を説明
  - Herschelでは受からない希薄成分
- triggered star formation
  - G319.88はless active SF
  - とはいえ、#4,#5はionization front(bright rim)に存在しており(C1,C2 clump)、triggered star formationの可能性がある
  - G010.32のほうがactiveなtriggered star formation

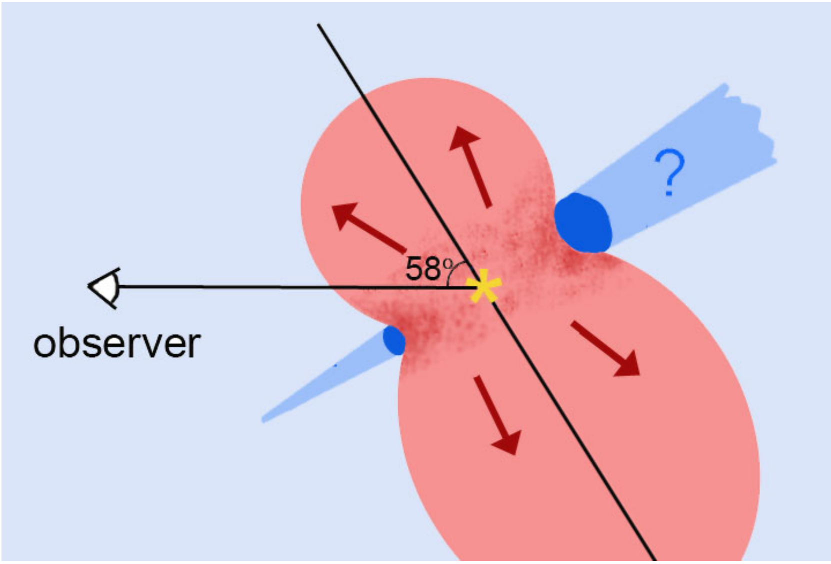


Fig. 27. Morphology of G319.88+00.79. The ionized material appears in pink, the neutral one in blue. We do not know the extent of the molecular material at the back of the nebula.

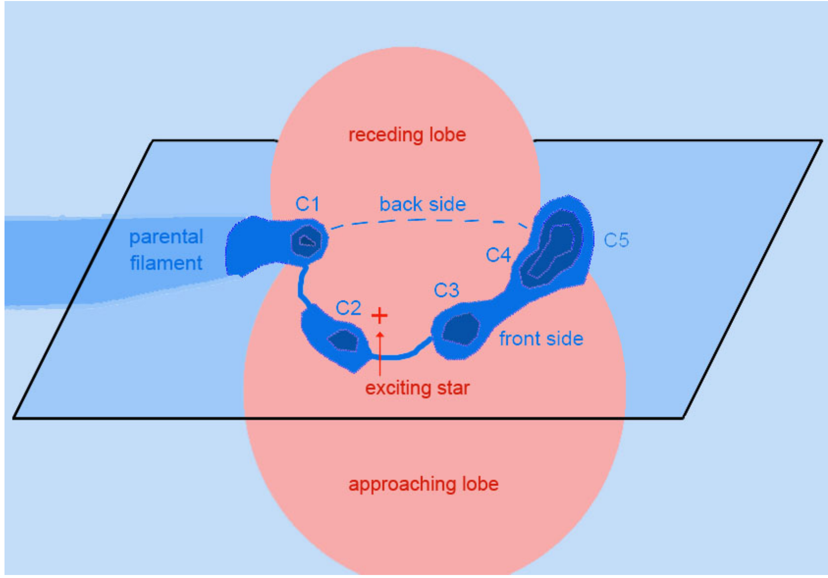


Fig. 28. Morphology of the G010.32–00.15 complex. The plane represented here contains the parental filament, the clumps at the waist of the nebula, and the exciting star. The line of sight makes a small angle with this plane.

Volatile depletion in the TW Hydrae disk atmosphere
Fujun Du et al.

- TWHya円盤のガス質量の差異
    - ~0.005$M_\odot$(CO等)
    - >0.05$M_\odot$(HD [Bergin+2013])
- 円盤表層からCOやH2Oが減少したと考えて解釈する
- C/Oの主な担い手
- 円盤構造を与えてシミュレーション
    - thermo-chemical + radiative transfer code [Du&Bergin+2014]
    - 温度構造を計算し静水圧平衡を仮定
    - C/Oのabundanceを変化させる

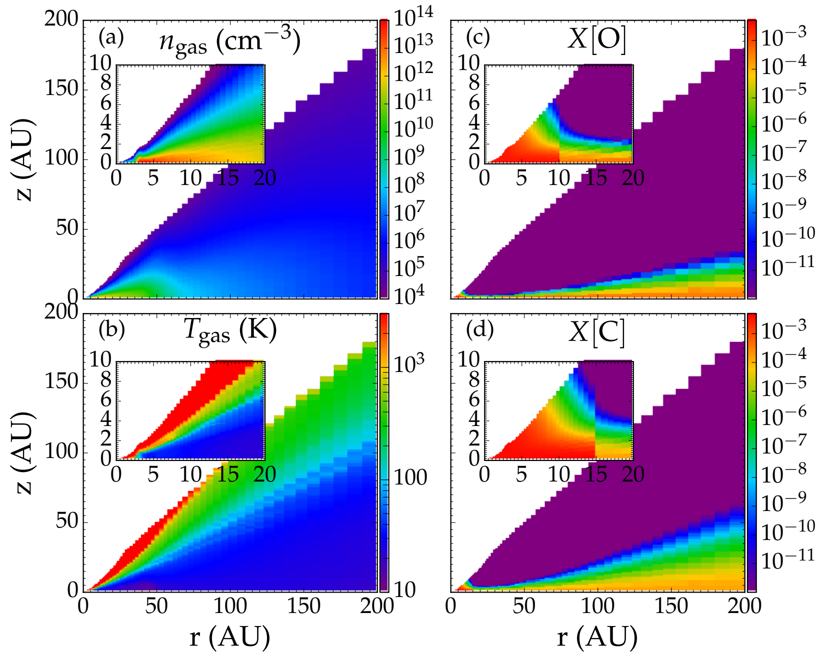


Fig. 1.— Distribution of disk physical parameters used in the models. (a): gas density distribution in the two models. (b): gas temperature distribution in the model in which the oxygen and carbon abundances are changed; for the model with full oxygen and carbon abundances, the gas temperature distribution is slightly different due to changes in the heating and cooling rates of oxygen- and carbon- bearing species. (c) and (d): distribution of oxygen and carbon abundances relative to hydrogen nuclei in the model in which their abundances are changed.

- high-J/回転振動COを説明する為、snowlineに向けてabundanceを徐々に増やす
- J-10-9,23-22のCOの説明には、10AUより内側でISMx10のabundanceが必要

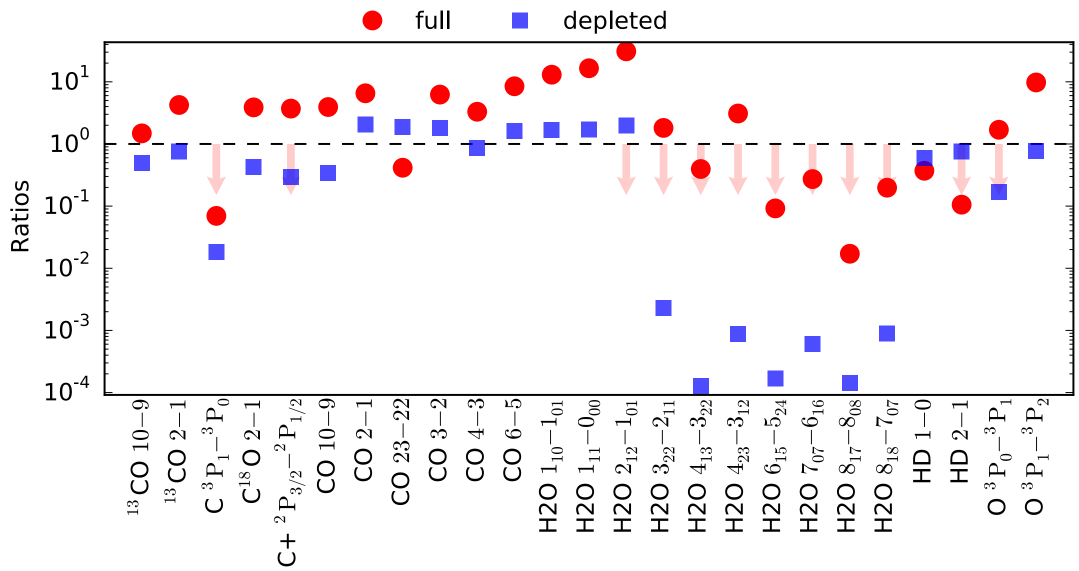


Fig. 2.— Ratios between the modeled and observed intensities for a selection of lines. Red dot: with full oxygen and carbon abundances; blue rectangle: with depleted oxygen and carbon abundances. The arrows mean that the observed values are upper limits. The relative measurement error of the observational data is usually much less than 50%. For the detected lines, a perfect fit would land on the dashed line.

=>full modelよりも観測を良く再現

- 表層でのC/O depletionの要因 =>ダストへの吸着と沈殿
    - 成長/沈殿によりUV desorption/dissociationを逃れる
    - TWHyaはturbulenceが弱くmixing起きにくい
- ダストはmigrationによって内側へ
    - 内側でのabundance上昇
    - C/O richな微惑星

Star formation scales and efficiency in Galactic spiral arms

D.J. Eden et al.

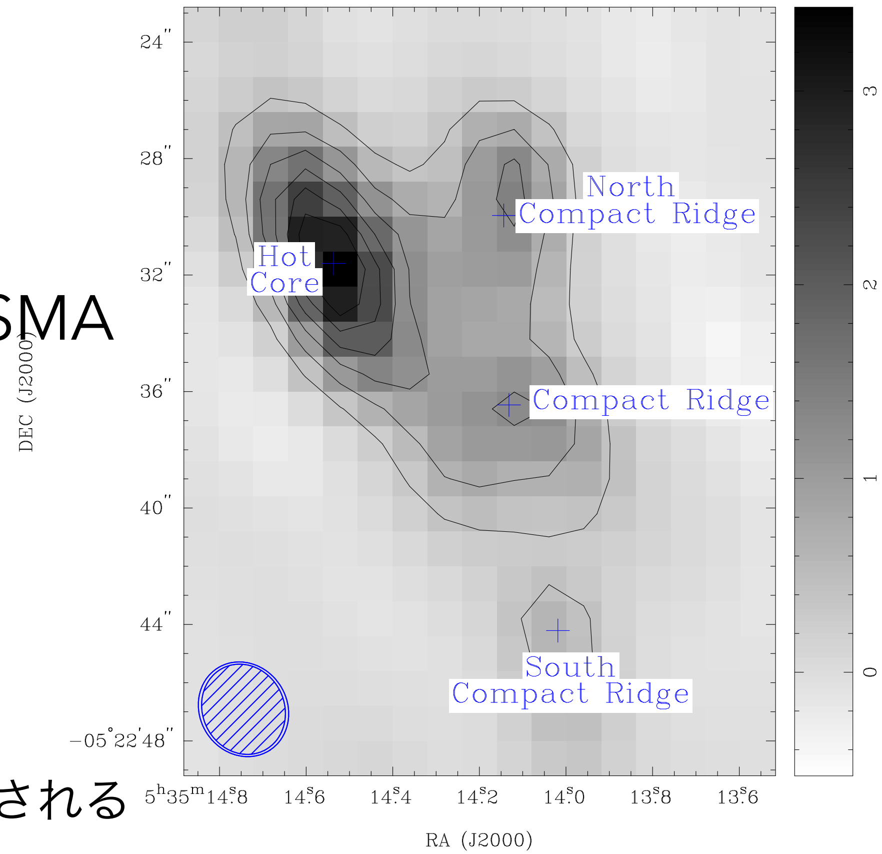
ABSTRACT

We positionally match a sample of infrared-selected young stellar objects (YSOs), identified by combining the *Spitzer* GLIMPSE, WISE and *Herschel Space Observatory* Hi-GAL surveys, to the dense clumps identified in the millimetre continuum by the Bolocam Galactic Plane Survey in two Galactic lines of sight centred towards $l = 30°$ and $l = 40°$. We calculate the ratio of infrared luminosity, $L_{\rm IR}$, to the mass of the clump, $M_{\rm clump}$, in a variety of Galactic environments and find it to be somewhat enhanced in spiral arms compared to the interarm regions when averaged over kiloparsec scales. We find no compelling evidence that these changes are due to the mechanical influence of the spiral arm on the star-formation efficiency rather than, e.g., different gradients in the star-formation rate due to patchy or intermittent star formation, or local variations that are not averaged out due to small source samples. The largest variation in $L_{\rm IR}/M_{\rm clump}$ is found in individual clump values, which follow a log-normal distribution and have a range of over three orders of magnitude. This spread is intrinsic as no dependence of $L_{\rm IR}/M_{\rm clump}$ with $M_{\rm clump}$ was found. No difference was found in the luminosity distribution of sources in the arm and interarm samples and a strong linear correlation was found between $L_{\rm IR}$ and $M_{\rm clump}$.

The distribution of deuterated formaldehyde within Orion-KL
C. Favre et al.

- Orion KLのD化物の調査
    - hot coreの初期低温状態の情報
    - 分子毎にD/H比が異なる
- Herschel HEXOS key programの発展でSMAの観測を行う
- H_2CO,HDCOに着目
    - grain surface reaction:メタノール生成仮定の中間
    - warm (50K) gas-phase reaction: CH2D+から生成される
- SMA観測
    - 空間分解能~3″、速度分解能~1.2km/s
    - HDCOの2輝線、para$H_2{}^{13}CO$の2輝線を観測

SMA連続波マップ



- 4つのHDCOピークを検出
    - dF4以外は$H_2{}^{13}CO$も付随
- D化メタノールと分布の違いがある

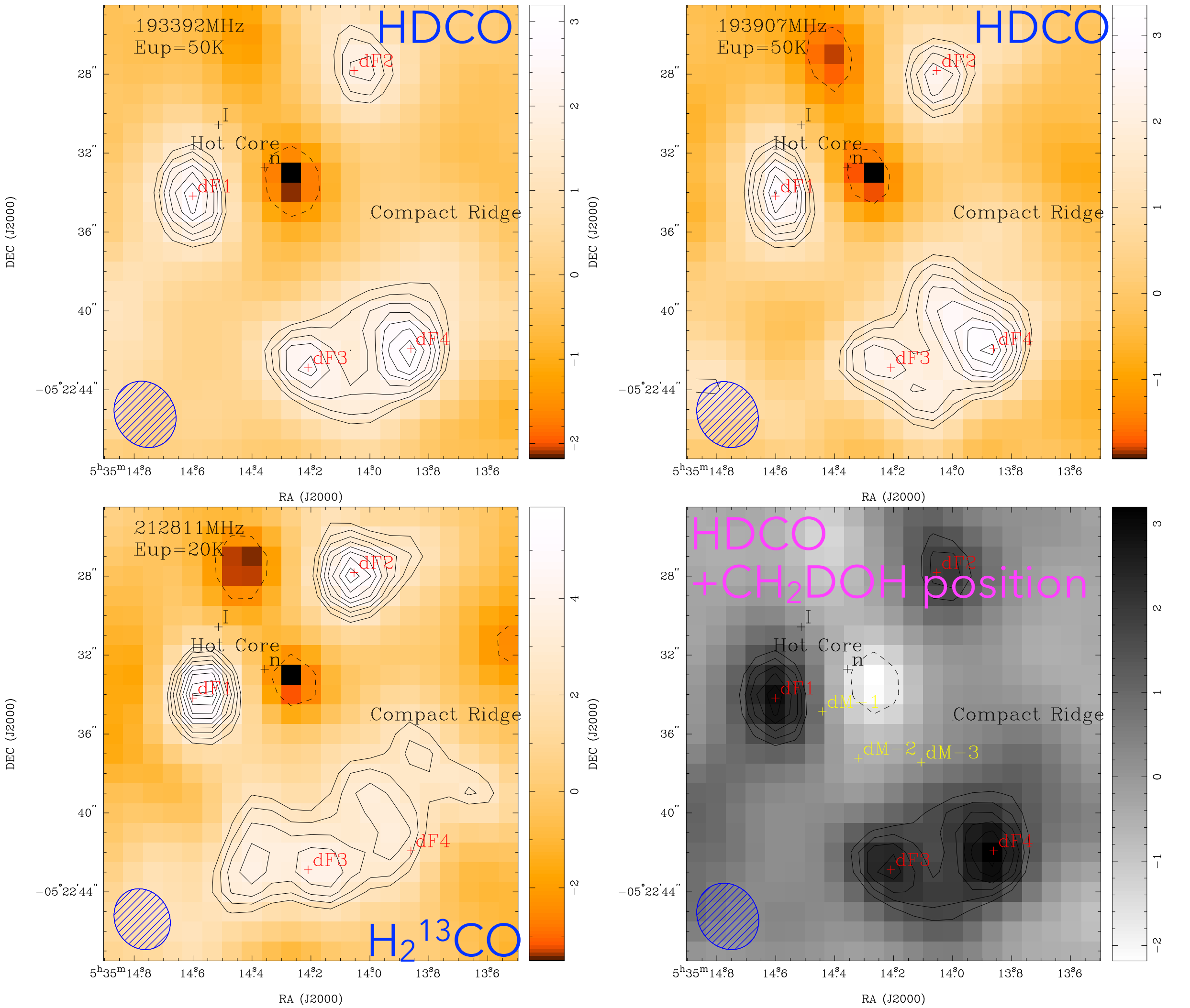
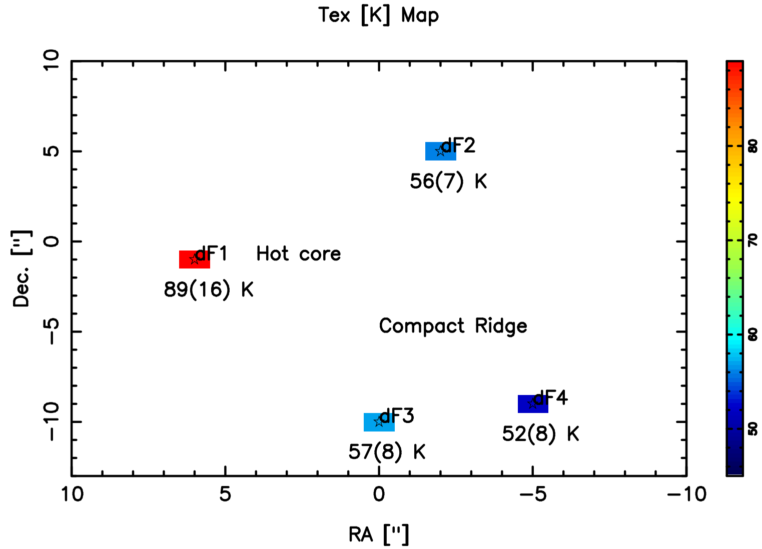
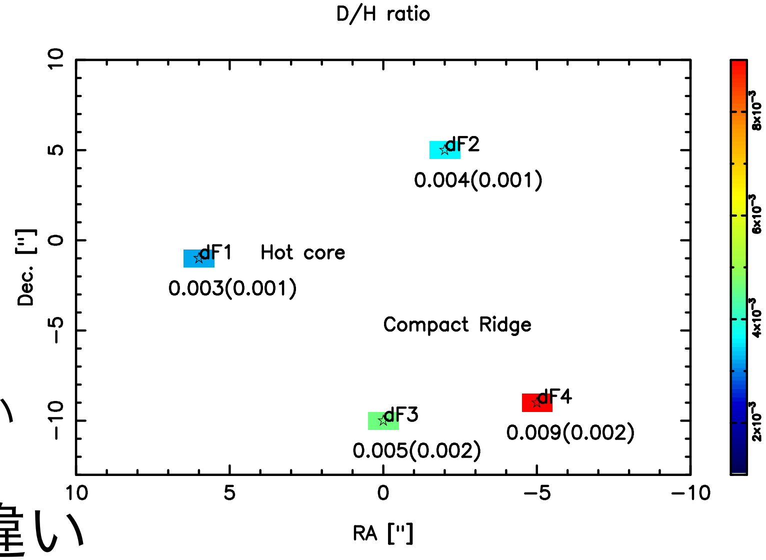


Fig. 2.— Formaldehyde integrated emission maps from v_{LSR}=6.5 km s^{-1} to v_{LSR}=10.0 km s^{-1}. Red crosses indicate the position of the regions dF1 to dF4. Black crosses indicate the positions of the radio source I (α_{J2000} = 05^{h}35^{m}14$\overset{s}{.}$5141, δ_{J2000} = -05°22′30$\overset{\prime\prime}{.}$575) and the IR source n (α_{J2000} = 05^{h}35^{m}14$\overset{s}{.}$3571, δ_{J2000} = -05°22′32$\overset{\prime\prime}{.}$719) (Goddi et al. 2011b). *Top:* HDCO emission at 193391.6 MHz (left panel) and 193907.5 MHz (right panel). *Bottom left:* $H_2^{13}CO$ emission at 212811.2 MHz. The first contour is at 5σ and the level step at 1σ (where σ=0.27 and 0.44 Jy beam^{-1} km s^{-1} for HDCO and $H_2^{13}CO$, respectively). *Bottom right:* same as the top left panel, expect for deuterated methanol emission peaks (in yellow) identified by Peng et al. (2012) are indicated.

- optically thin, LTEを仮定して、Texと柱密度およびD/Hを導出
  - Texはhot coreで大きい
  - D/Hは南側のridgeで大きい
  - D/H比はメタノールより一桁大きい





- ホルムアルデヒド放射の起源と生成
  - OrionBarとH_2CO/CH_3OHを比較
    ->数桁小さく光解離によるH_2CO形成はメインではない
- ホルムアルデヒド-メタノールでのD/H比の違い
  - ダスト表面反応であれば同程度になるはずだが観測結果は違う
  - hot gas-phase deuterium chemistry in colder gas
    - 70-100K程度で$CH_3^+ + HD \leftrightarrow CH_2D + H_2 + \Delta E$がactiveに
    - coldなガス内でホルムアルデヒドが生成される (D化物の増加)