星形成ゼミ・報告 (SFN #310 N.55-58)資料

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紹介しない論文

55 **EPIC 203868608: A low-mass quadruple star system in the Upper Scorpius OB association**

Ji Wang[1,2], Trevor J. David[1,3], Lynne Hillenbrand[1], Dimitri Mawet[1], Simon Albrecht[4], and Zibo Liu[5]

ALMA reveals a collision between protostellar outflows in BHR 71

Luis A. Zapata[1], Manuel Fernández-López[2], Luis F. Rodrıguez[1], Guido Garay[3], Satoko Takahashi[4], Chin-Fei Lee[5], and Antonio Hernández-Gómez[1,6]

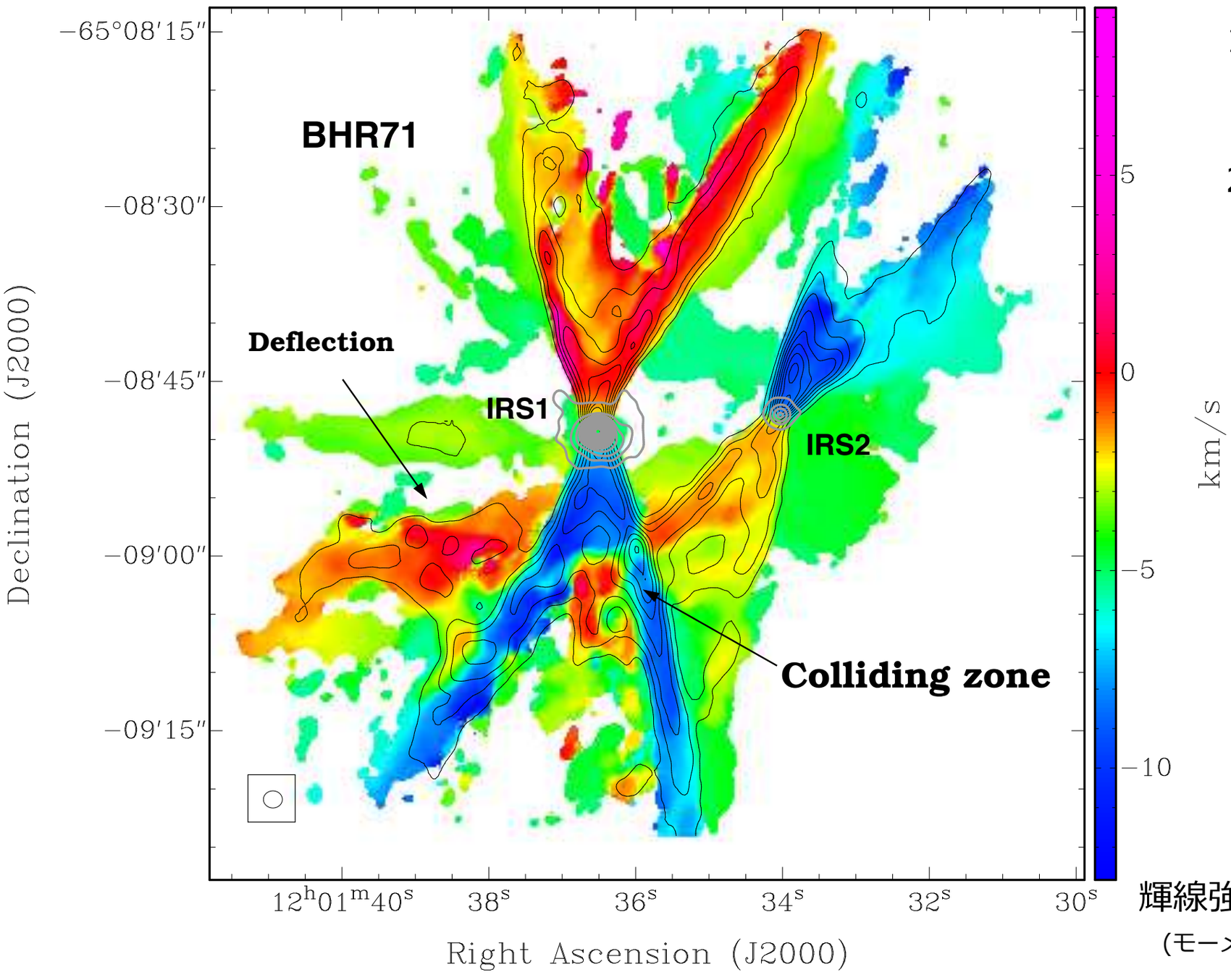


Figure 2. ALMA ^{12}CO(2-1) intensity-weighted velocity (moment one) (color-scale), ^{12}CO(2-1) integrated intensity (black contours), and 1.3 mm continuum (grey contours) images of BHR 71. The half-power synthesized beam size is shown in the bottom left corner. The radial velocity scale-bar is shown in the right. The black contours are starting from 10% to 80% in steps of 10% of the intensity peak. The CO intensity peak is 13.9 Jy Beam^{-1} Km s^{-1}. The grey contours are starting from 2% to 90% in steps of 2% of the intensity peak. The 1.3 mm continuum intensity peak is 0.4 Jy Beam^{-1}.

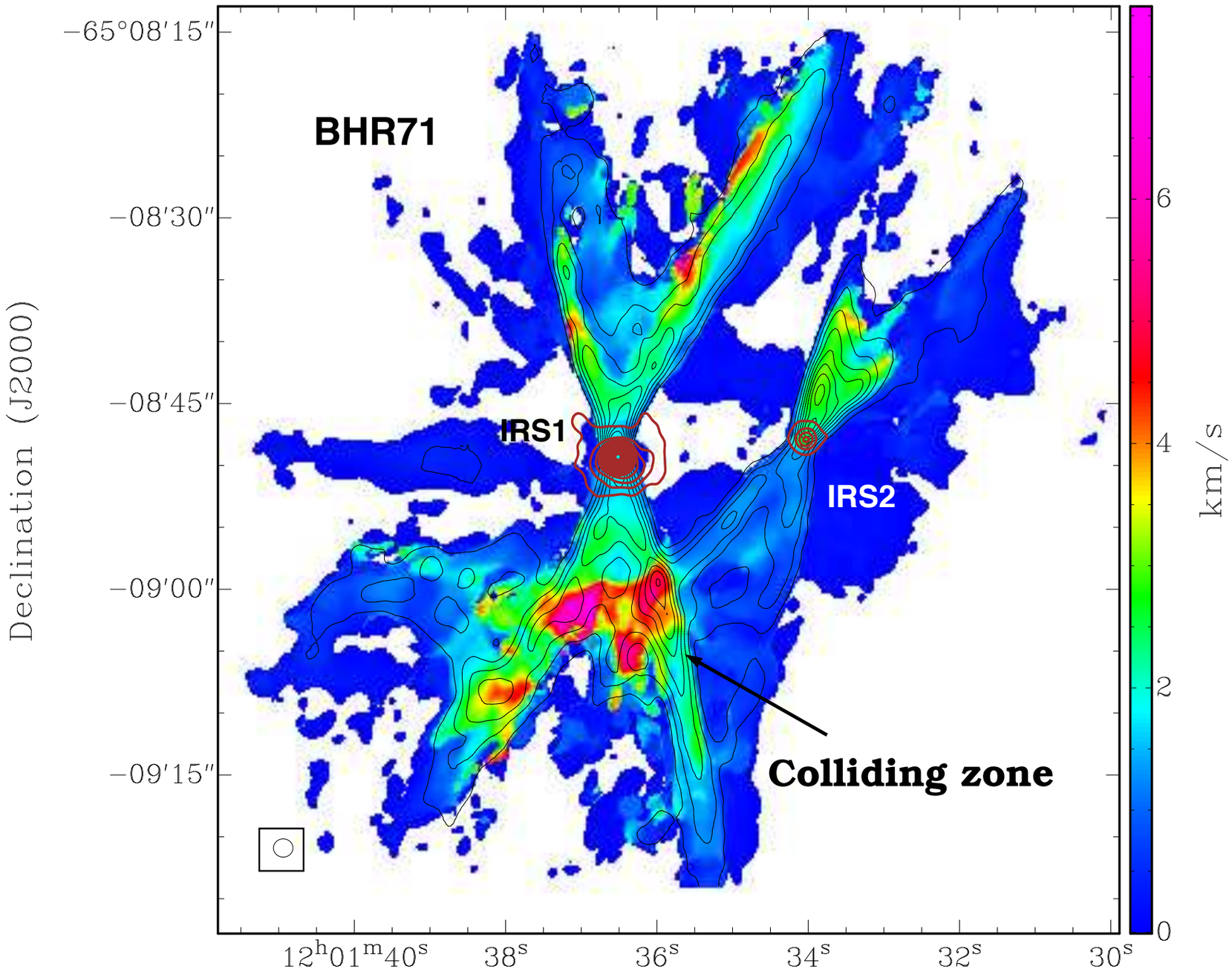
要旨

1. 分子流と分子流が相互作用する系(3例目)をALMAでは初めて見つけた.

2. 【中心星のひとつ ; BHR71 IRS1】
   - L_{bol} = 13.5 +/- 1.0 L_{sun}
   - $M_{dusty\ envelope}$ = 0.215 +/- 0.003 M_{sun}(ALMA), 19M_{sun}(ハーシェル衛星)
   - 分子流の力学年齢の下限値は,
     GREG> say '200*30*au|(25e5)|yr'
     1.1384E+03年くらい, second collapse後それほど時間は経っていないか？

輝線強度で重み付け平均した視線速度マップ

(モーメント計算時の速度範囲は-25 < V-V_{sys} (km/s) < 20)



輝線強度で重み付け平均した視線速度の速度幅マップ

(モーメント計算時の速度範囲は-25 < V-Vsys (km/s) < 20)

Figure 3. ALMA ^{12}CO(2-1) intensity-weighted square root velocity (moment two) (color-scale), ^{12}CO(2-1) integrated intensity (black contours), and 1.3 mm continuum (brown contours) images of BHR 71. The half-power synthesized beam size is shown in the bottom left corner. The radial velocity scale-bar is shown in the right. The black contours are starting from 10% to 80% in steps of 10% of the intensity peak. The CO intensity peak is 13.9 Jy Beam^{-1} Km s^{-1}. The brown contours are starting from 2% to 90% in steps of 2% of the intensity peak. The 1.3 mm continuum intensity peak is 0.4 Jy Beam^{-1}.

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On the origin of magnetic fields in stars

James Wurster[1], Matthew R Bate[1] and Daniel J Price[2]

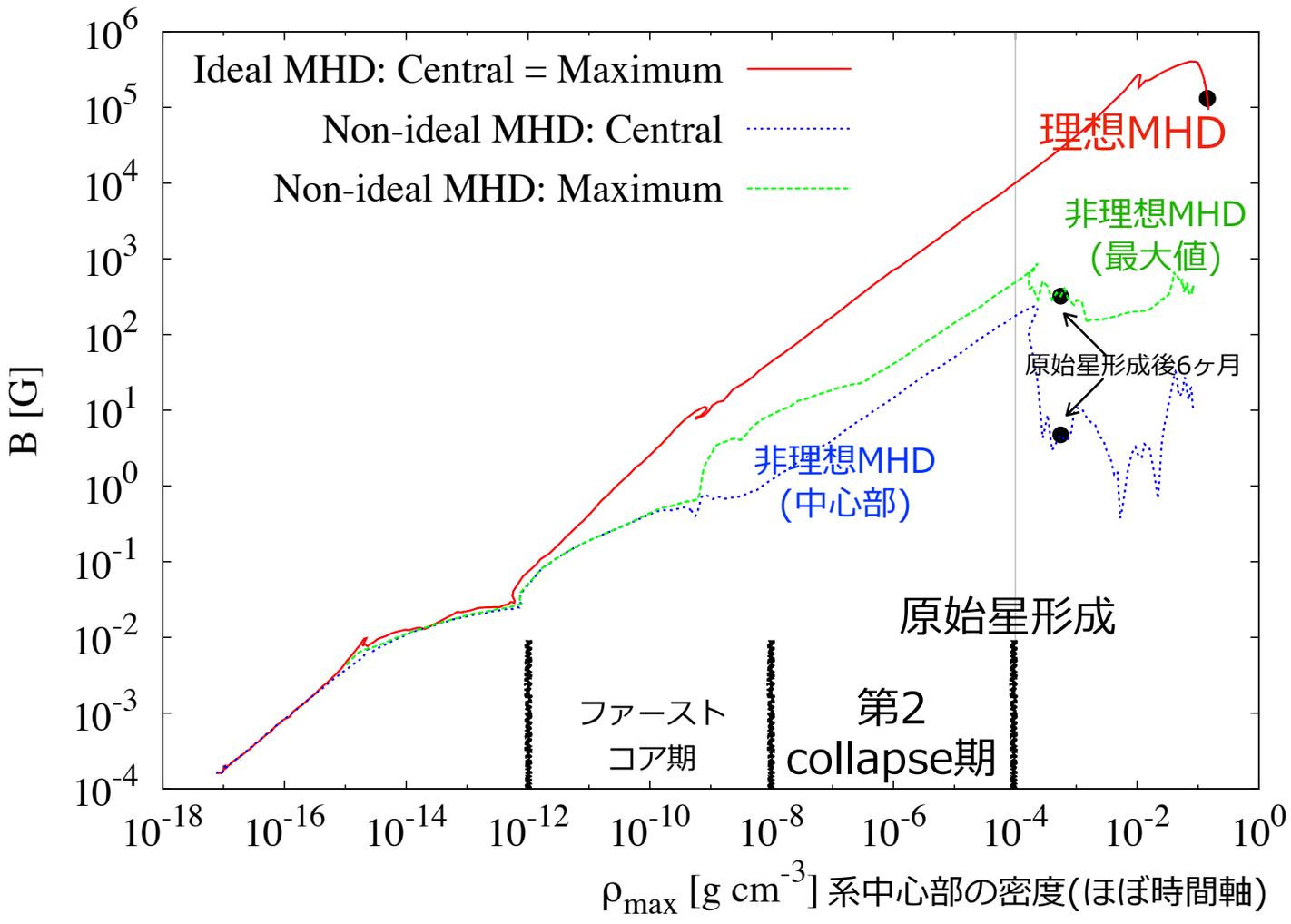


Figure 1. Evolution of the magnetic field strength against maximum density, which is a proxy for time. The vertical grey line indicates the formation density of the stellar core, and the black circles are placed 6 months after the formation of the stellar core for each model (i.e. $dt_{sc} = 0.5$ yr). For both models, the maximum density is coincident with the centre of the system (i.e. $\rho_{max} = \rho_{cen}$). In the ideal MHD model, the maximum and central magnetic field strength are the same for the entire simulation. In the non-ideal MHD model, the central and maximum magnetic field strengths are no longer coincident near the end of the first core phase, and at stellar core formation, are a few orders of magnitude lower than the values in the ideal MHD model.

要旨

1. 【着眼点】若い星[文脈から前主系列星(PMS)？]で観測されるkGオーダーの磁場強度は原始星形成時にあったものか、それともPMS進化におけるダイナモで増幅されたものか？

2. 【手法】非理想MHD効果(双極性拡散, オーム損失, ホール効果)＋回転を考慮し, 分子雲コア(初期にR=0.013pc, 等温, 回転と重力のエネルギー比=0.005, 臨界値に対する質量磁束比μ=5,適切な宇宙線電離度ζ=1e-17 1/sec)から原始星形成直後までを計算.

3. 【結論】

   (i)理想MHD(磁場と物質がカップル)では観測事実(?)を説明できない.

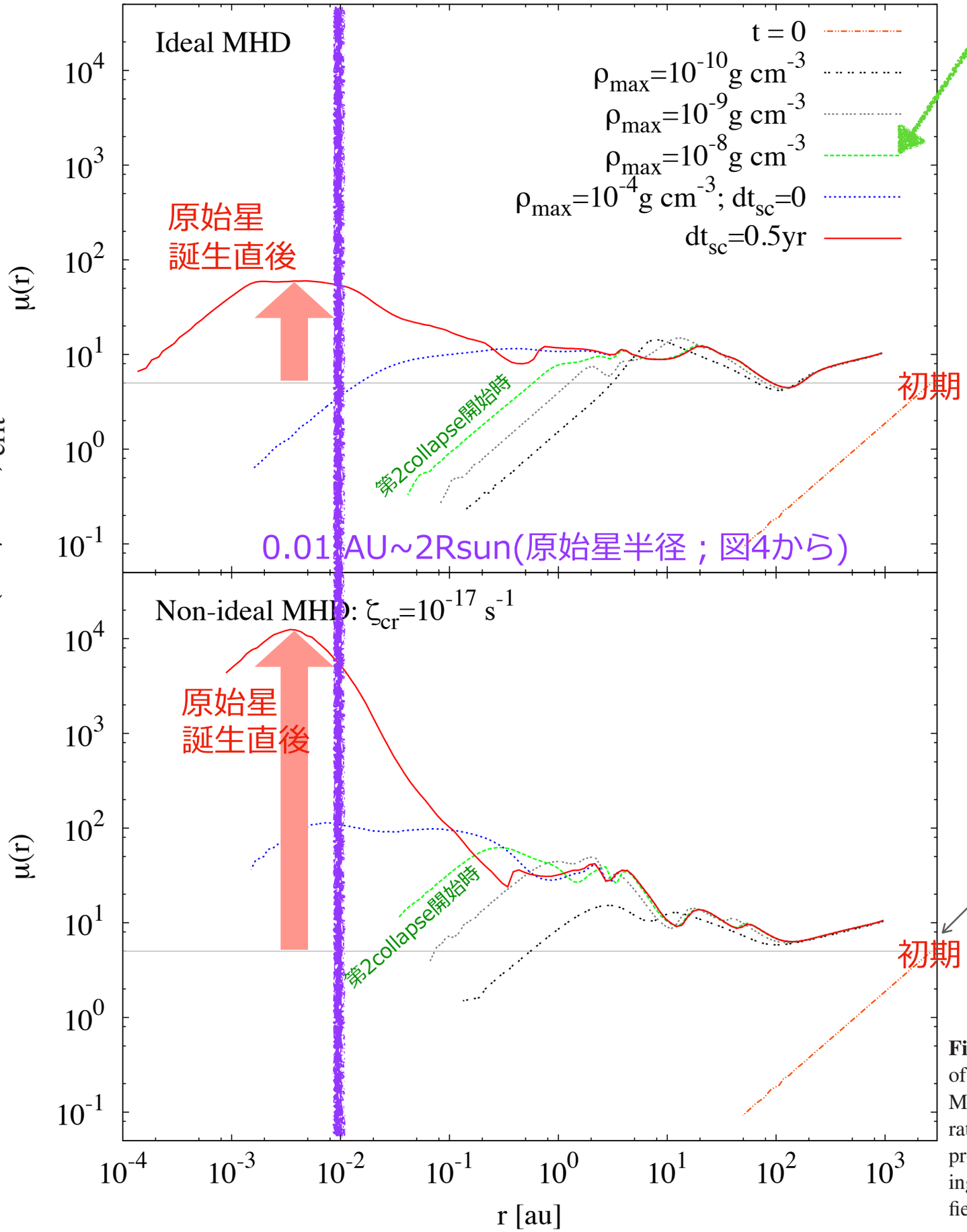
   (ii)誕生直後の原始星はr~1-3AUの“magnetic wall”(図2参照)で囲まれており、壁での最大磁場強度は~900G, 中心星を含めた壁内部では~240G以下.

   (iii)つまり, PMSで観測されるkGオーダーの磁場はPMS進化中に増幅されたものだろう.

【この論文と直接比較されている先行研究】

Tsukamoto+15a, 15b, 17

図3



$$\mu(r) \equiv \frac{M/\Phi_B}{(M/\Phi_B)_{\rm crit}},$$

図2: ファーストコア期最終盤での磁場構造

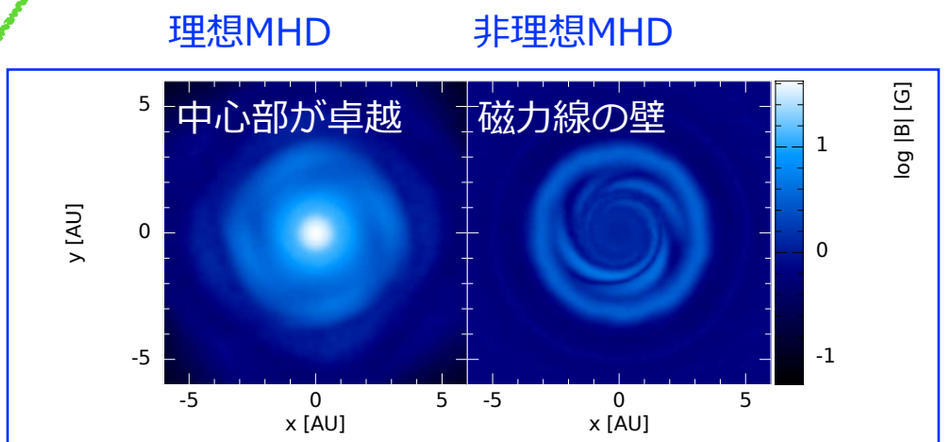


Figure 2. Density (top) and magnetic field strength (bottom) slices through the first hydrostatic core perpendicular to the rotation axis for the ideal (left) and non-ideal (right) MHD models once the maximum density has reached $\rho_{\rm max} \approx 10^{-8}$ g cm^{-3} (near the end of the first core phase). The initial magnetic field strength in both models is five times the critical mass-to-flux ratio. The density slices are qualitatively similar. The magnetic field strength follows the density profile in the ideal MHD model, while the maximum magnetic field strength in the non-ideal MHD model is in a structured torus at 1-3 au from the centre of the core.

$$\mu = \frac{M/\Phi_{\rm B}}{(M/\Phi_{\rm B})_{\rm crit}} = \frac{\frac{M(r)}{\pi r^2 B(r)}}{\frac{c1}{3\pi}\sqrt{\frac{5}{G}}} \simeq$$

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GREG> say 'Msun|(pi*(0.013*pc)**2*163e-6)|((.53|(3*pi)*sqrt(5|G)))'
4.987
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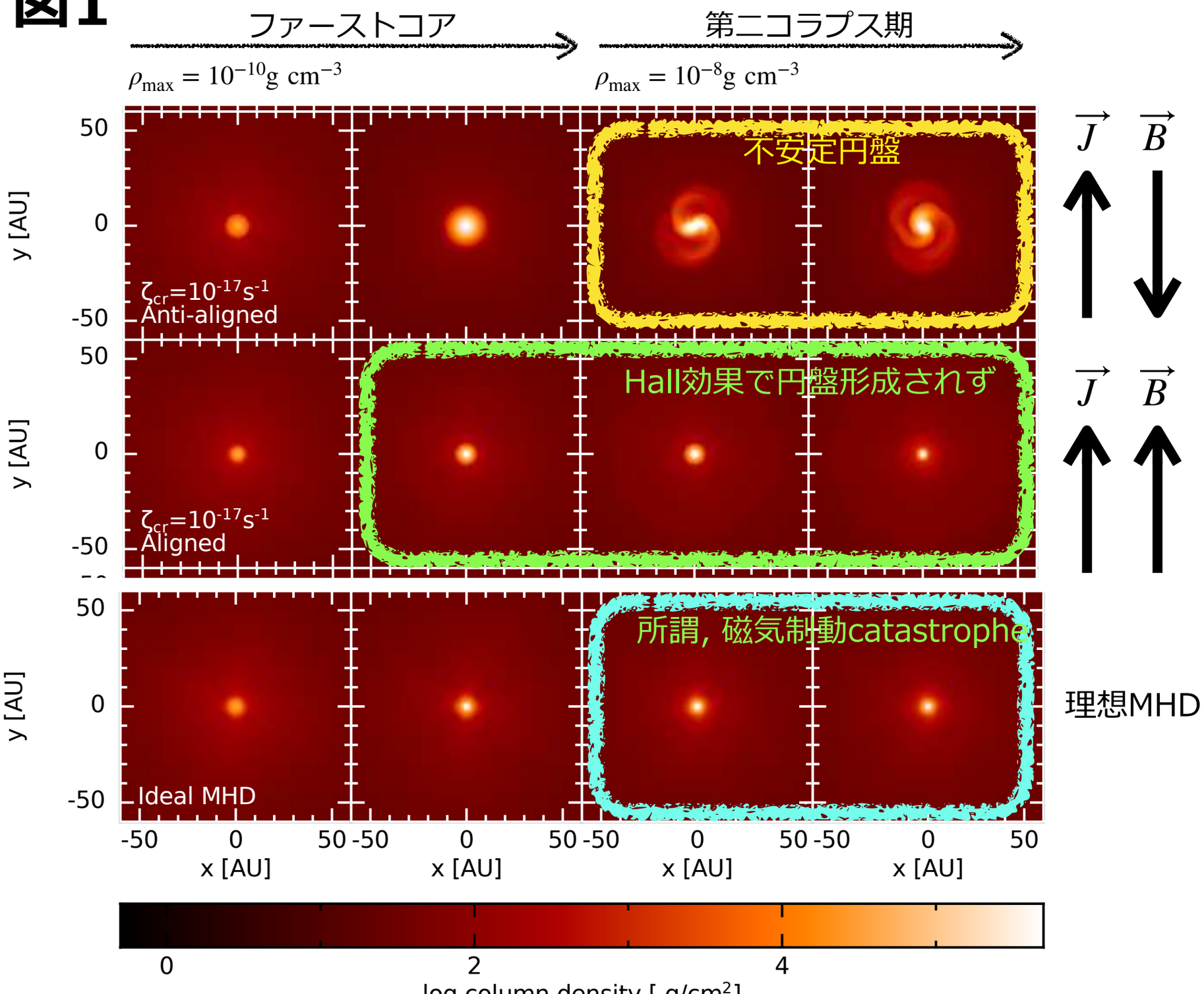
Figure 3. The mass-to-flux ratio in units of the critical value as a function of radius at six different epochs for the ideal (top) and non-ideal (bottom) MHD models. The horizontal grey line represents the initial mass-to-flux ratio, $\mu_0 = 5$. At $t = 0$, $\mu(r) = \mu_0 = 5$ at $r = R_{\rm c}$. The non-ideal MHD processes diffuse the magnetic field even by $\rho_{\rm max} \approx 10^{-10}$ g cm^{-3}, yielding $\mu_{\rm non\text{-}ideal}(r) > \mu_{\rm ideal}(r)$. There is significant diffusion of the magnetic field for $r \lesssim 10$ au in the non-ideal MHD model.

56 Hall effect-driven formation of gravitationally unstable discs in magnetized molecular cloud cores

James Wurster[1], Matthew R Bate[1] and Daniel J Price[2]

図1



要旨

1. 55番論文の結果のうち、不安定な円盤の形成に焦点

2. 【新しさ】非理想MHD効果3つを入れて, 分子雲コアから前主系列段階(のうち, ごく)最初まで, 角運動量ベクトル***J***と磁場ベクトル***B***が平行と反平行の場合を解いた.

3. 【結果】

(i)図1の　　部分でr~25AUの円盤形成されるので、所謂, 磁気制動catastropheの問題を解決.

(ii)ファーストコア段階で分子流が駆動される.

- 反平行のとき低速(<0.3 km/s)分子流
- 平行のとき高速(>3 km/s)分子流

図2

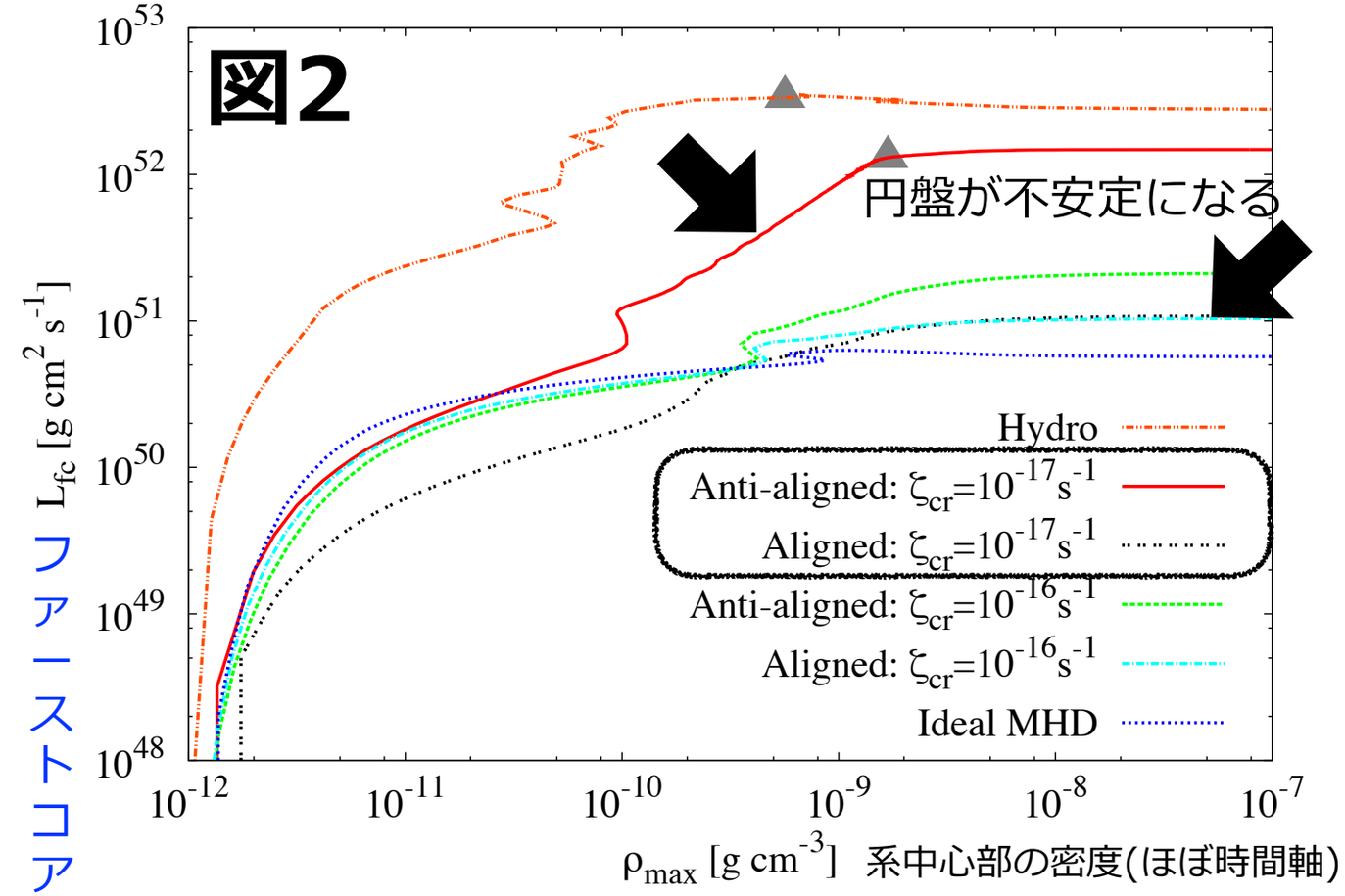
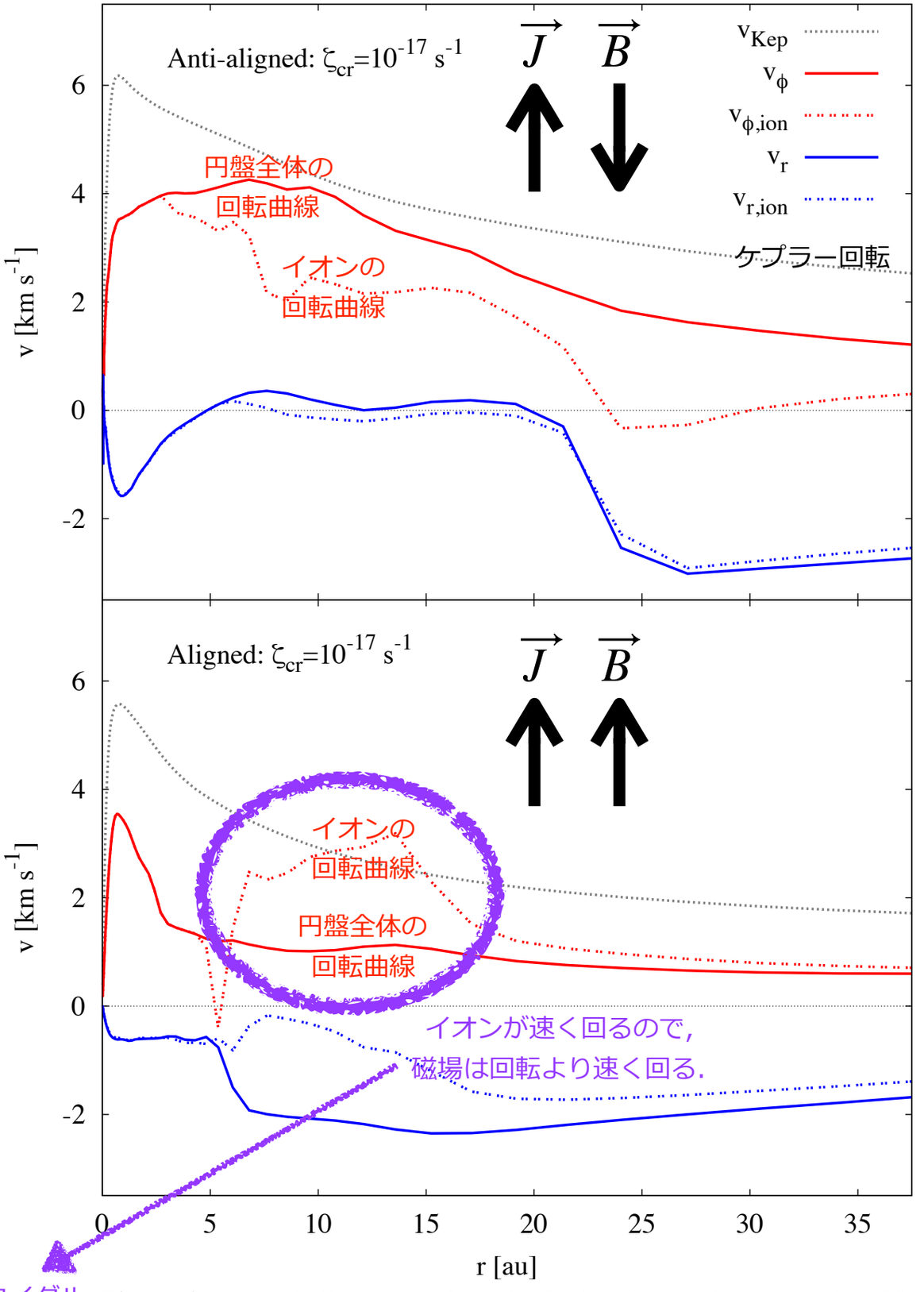


Figure 2. Evolution of the angular momentum in the first hydrostatic core (defined as the gas with $\rho \geq 10^{-12}$ g cm^{-3}). The triangles represent when the discs becomes gravitationally unstable. The angular momentum in the first core is larger for models with lower ionization rates, and with initially anti-aligned magnetic field and rotation vectors.

ファーストコア内角運動量



より顕著なトロイダル磁場をつくる.

Figure 3. Azimuthally averaged single-fluid and ion velocities within 20° of the midplane at $\rho_{\rm max} \approx 10^{-7}$ g cm^{-3} for models ζ_{17}^{-} (top) and ζ_{17}^{+} (bottom). The gas is rotating at sub-Keplerian velocities. The ions are rotating slower than the bulk rotational flow in ζ_{17}^{-}, decreasing the magnetic braking and promoting disc formation.

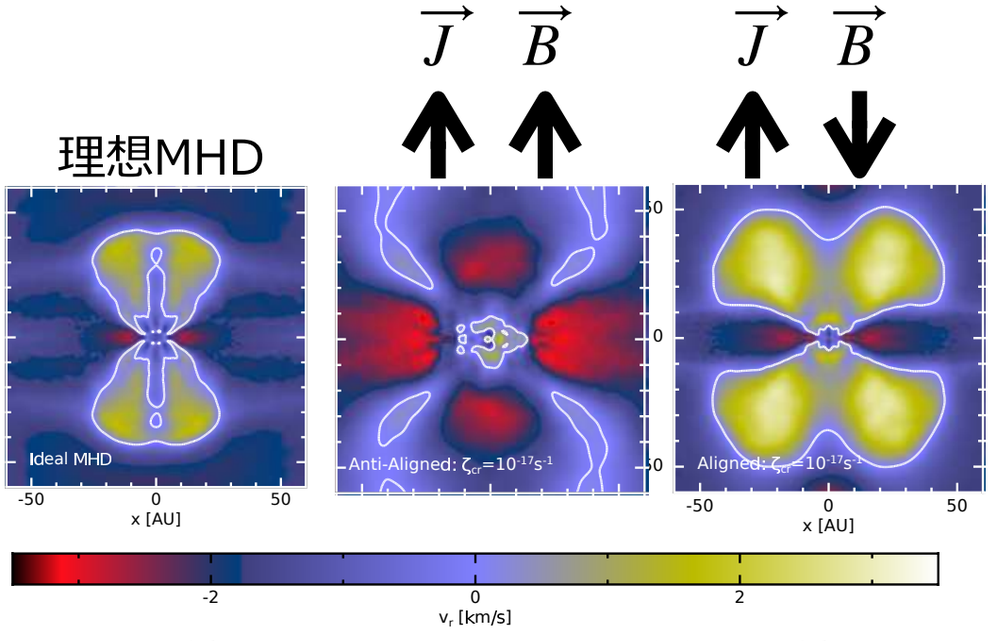


図9: 分子流速度の視線成分