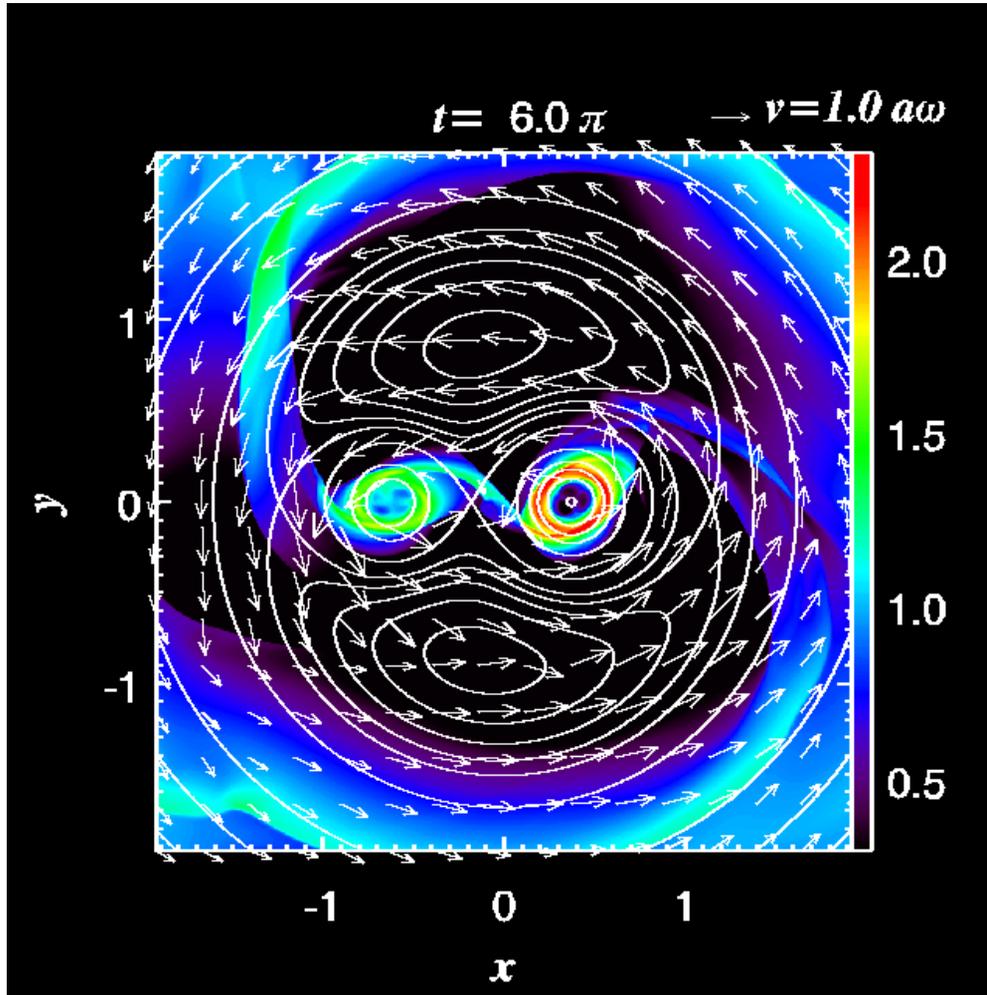


ガス降着による連星の成長



越智 康浩

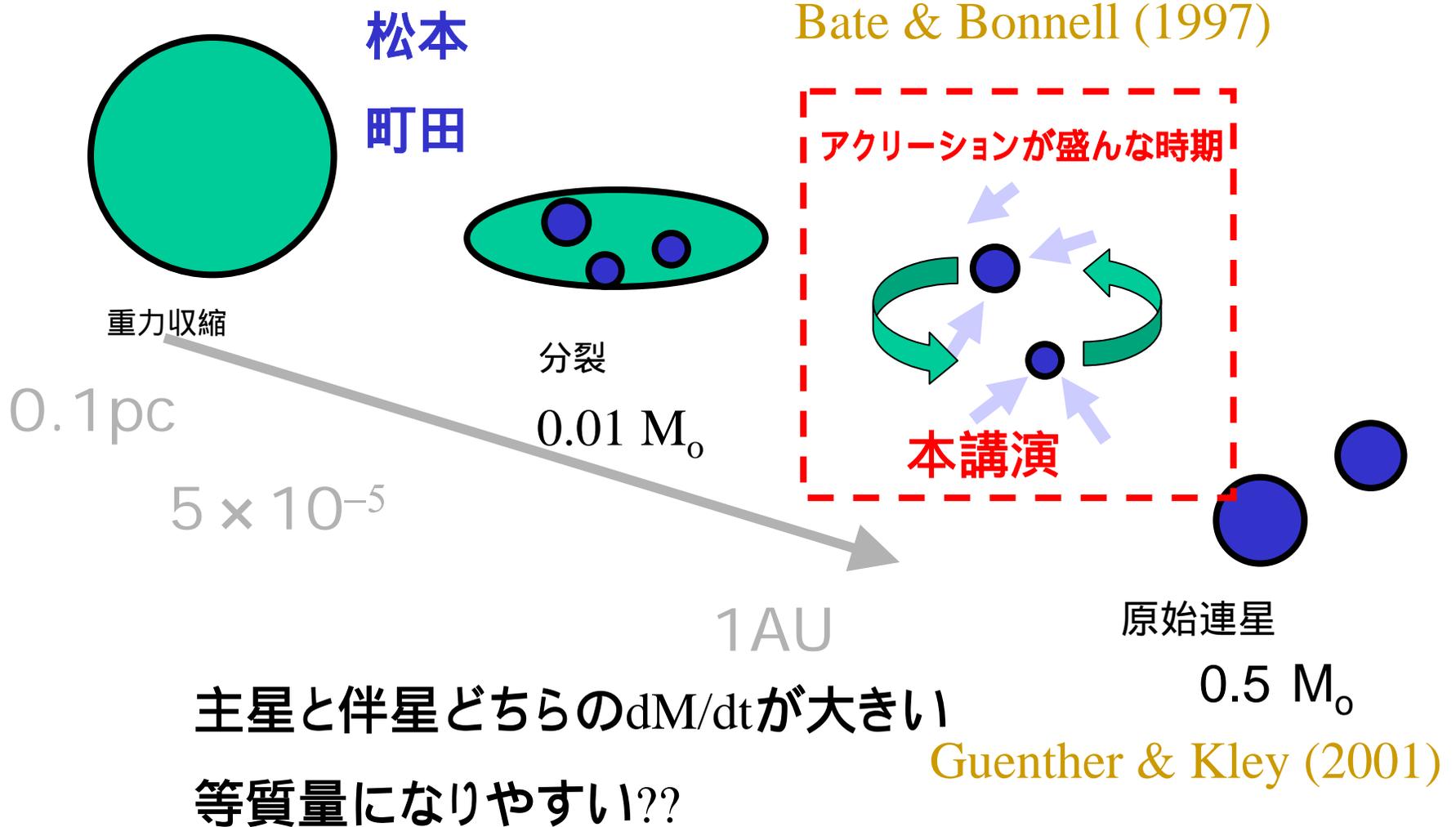
杉本 香菜子

(千葉大学/名古屋大学)

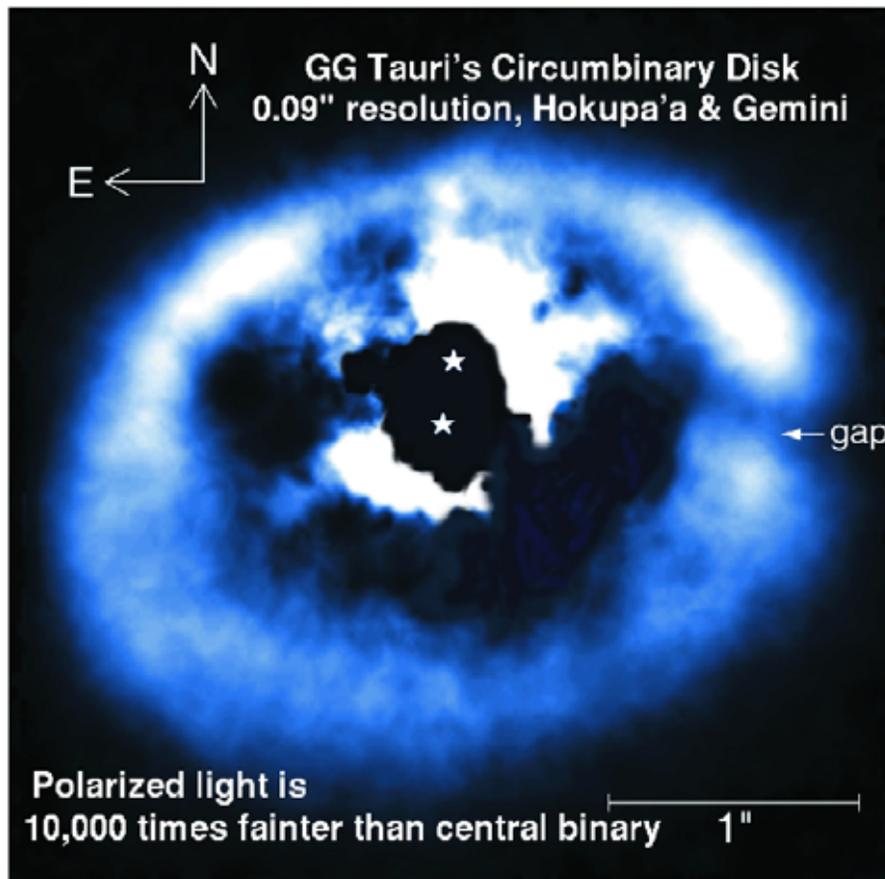
花輪 知幸

(千葉大学)

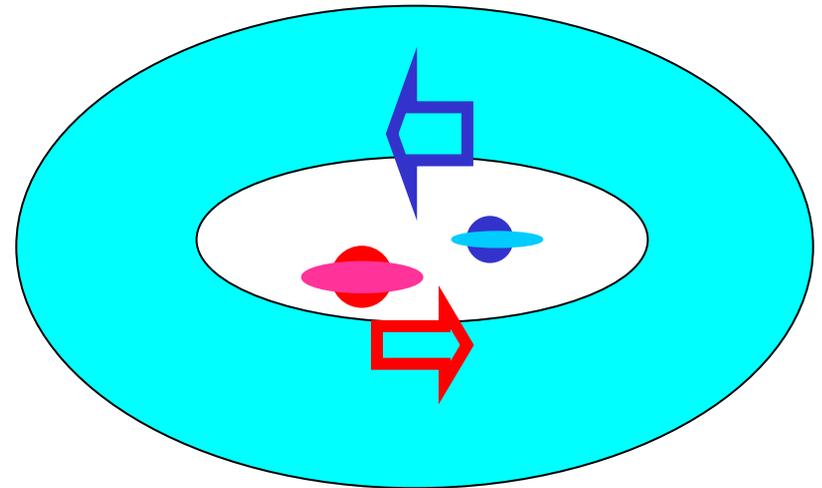
アクリーションが盛んな時期も連星



アクリーションが盛んな時期の連星をモデル化

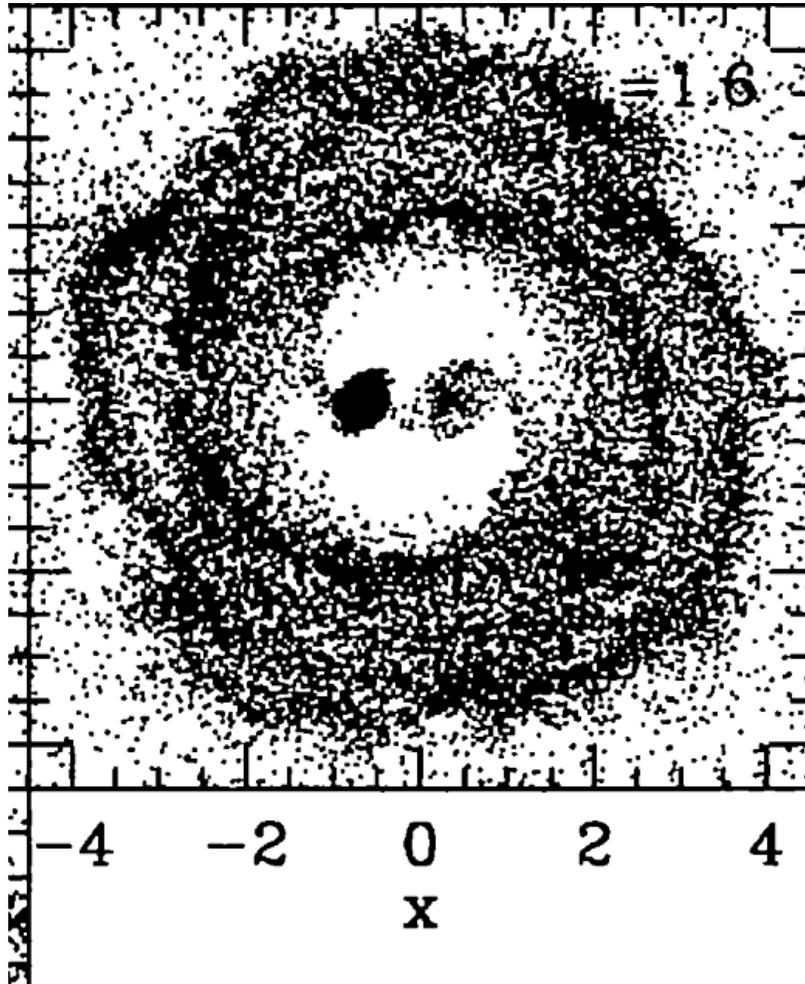


周連星円盤の中に星周円盤をもつ主星と伴星



cf. Bate & Bonnell (1997)

Bate & Bonnell (1997)



3D SPH simulation

伴星は軌道半径
が大きいため、質
量降着率が高い。

2D モデル

円軌道

$$a = 1, \quad = 1$$

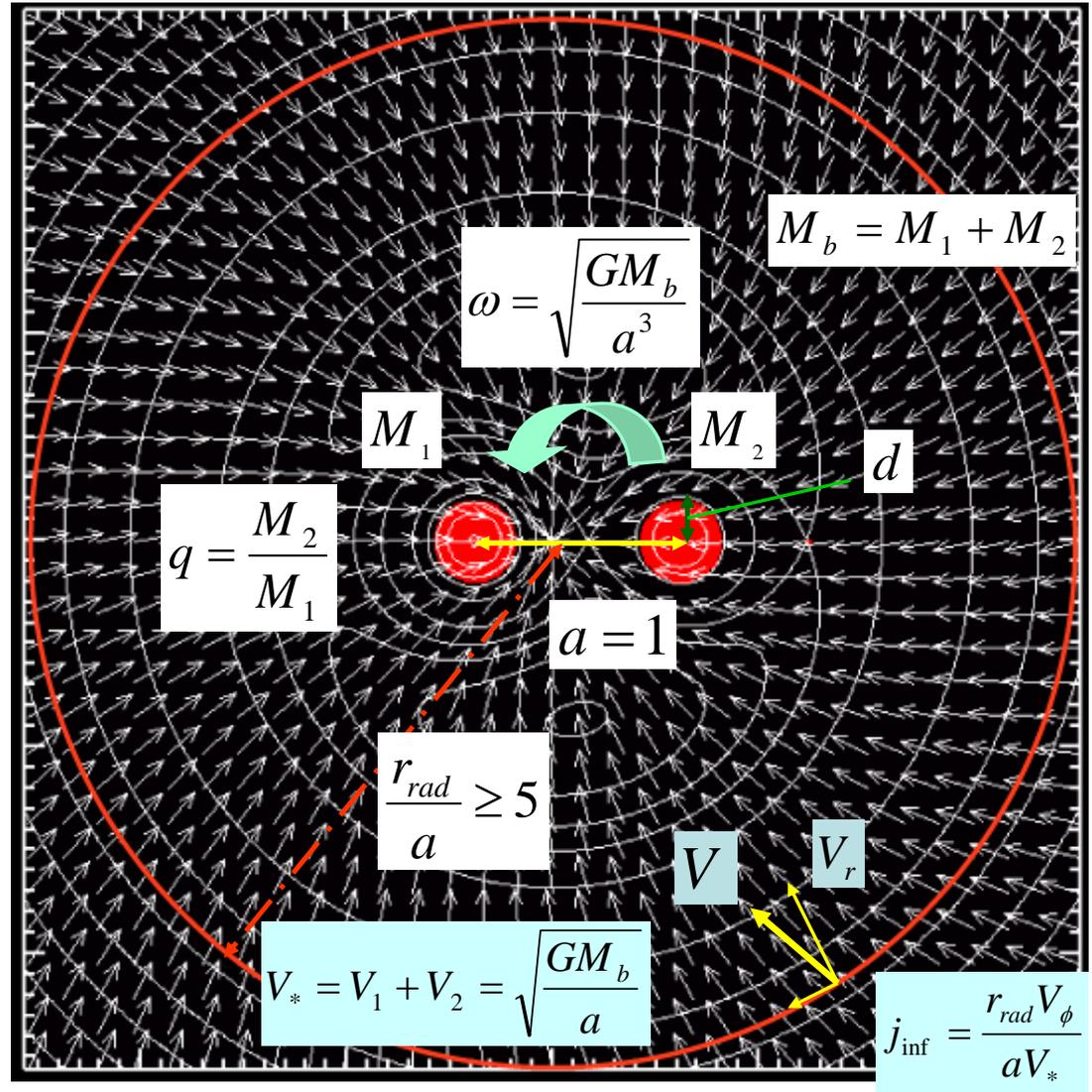
q : 質量比 M_2/M_1

j_{inf} : 比角運動量

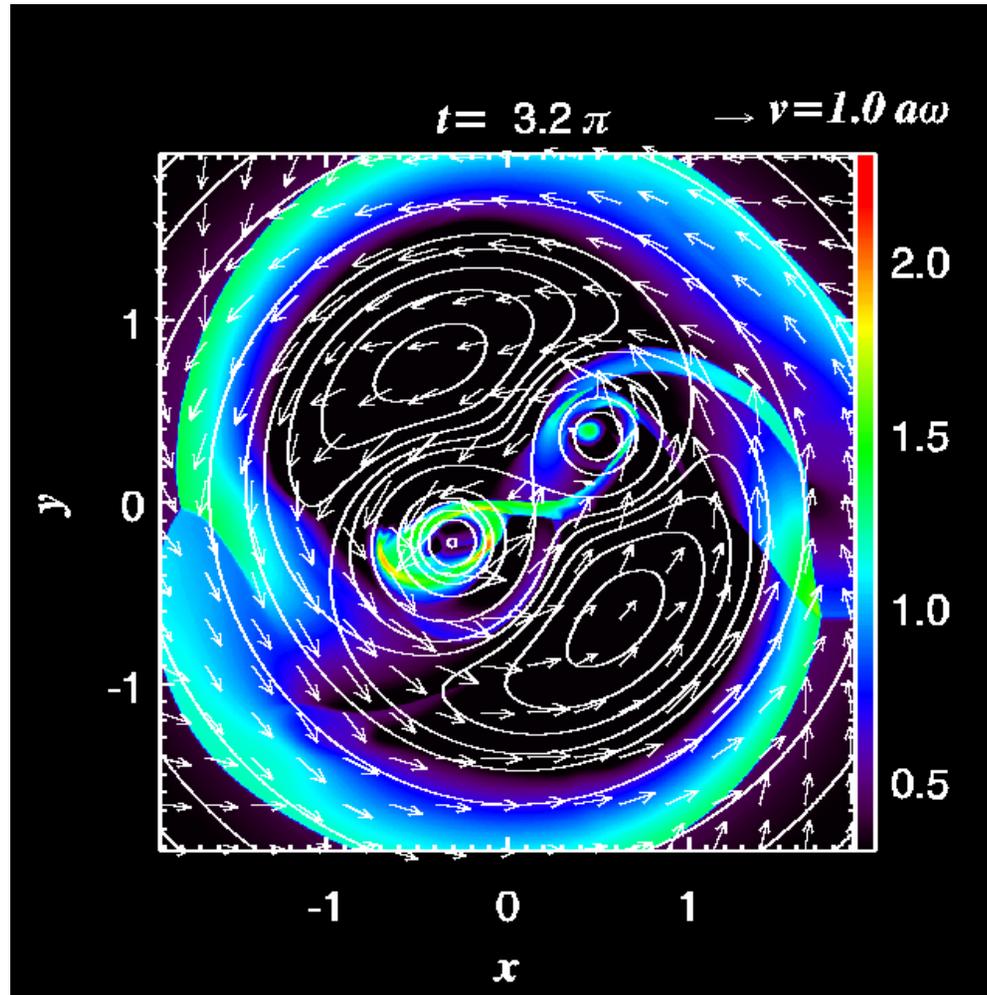
$$j_{\text{inf}} = 1 \quad (\text{const.})$$

$$E_{\text{inf}} = 0 \quad (\text{const.})$$

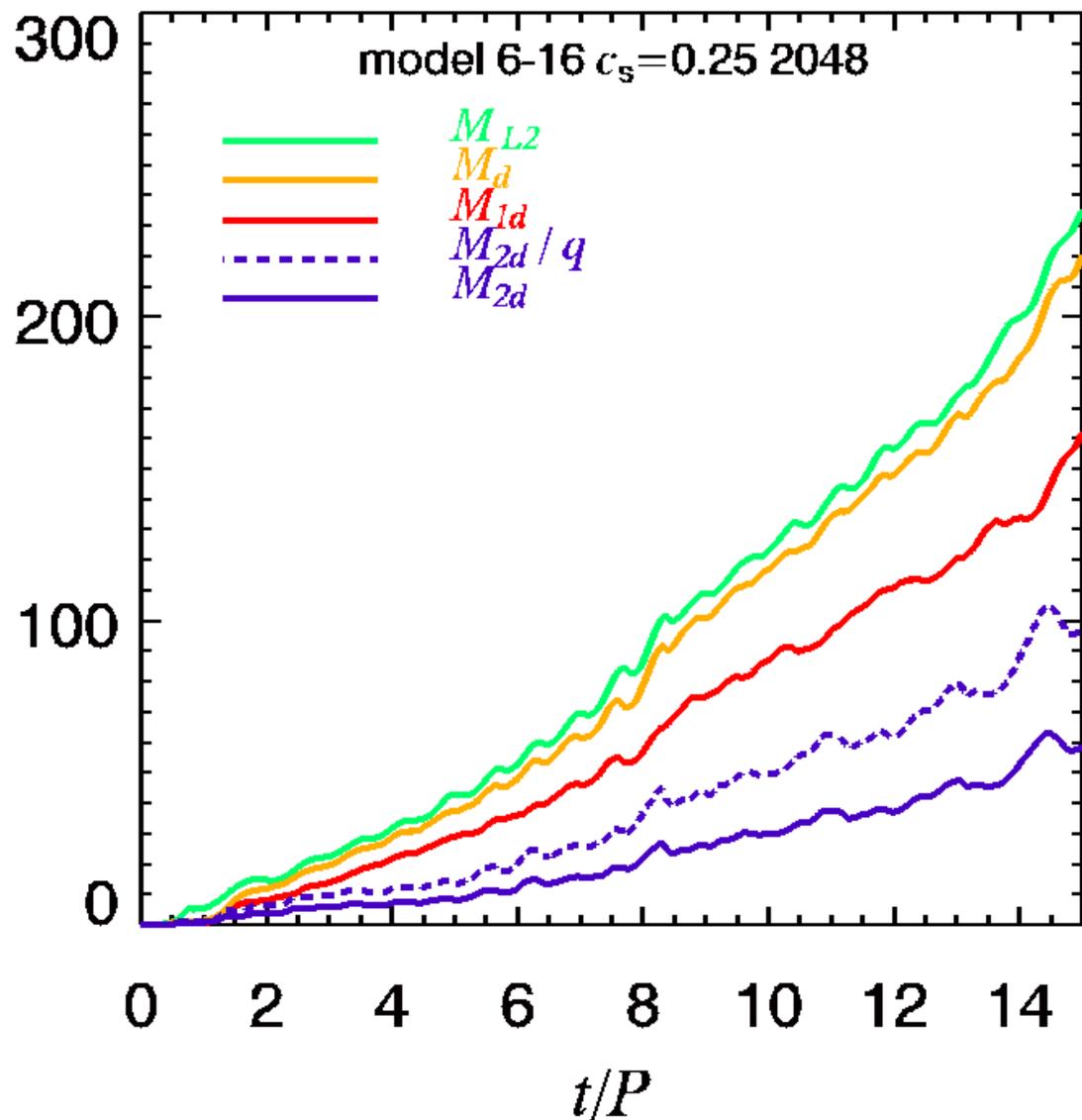
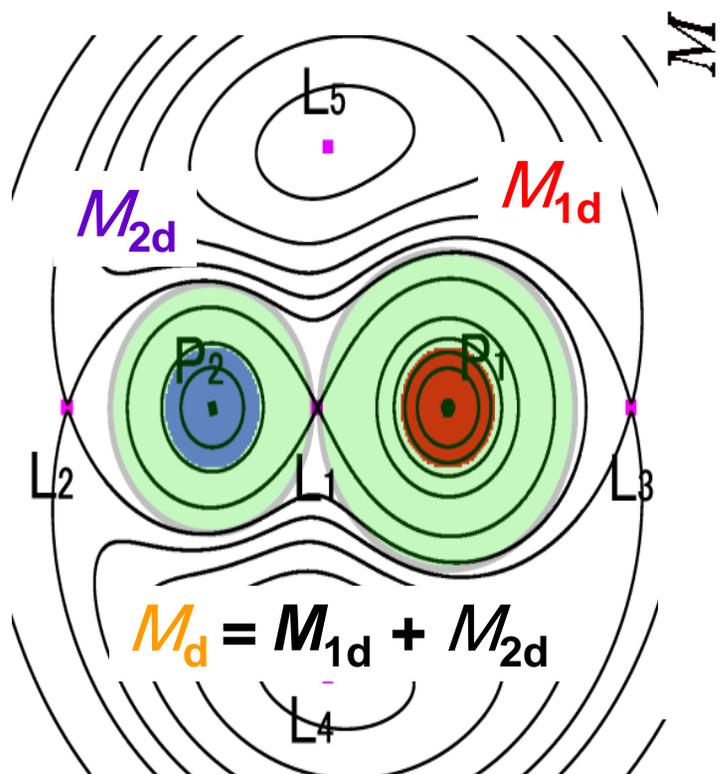
1024², 2024², 3072²,
& 4096² cells



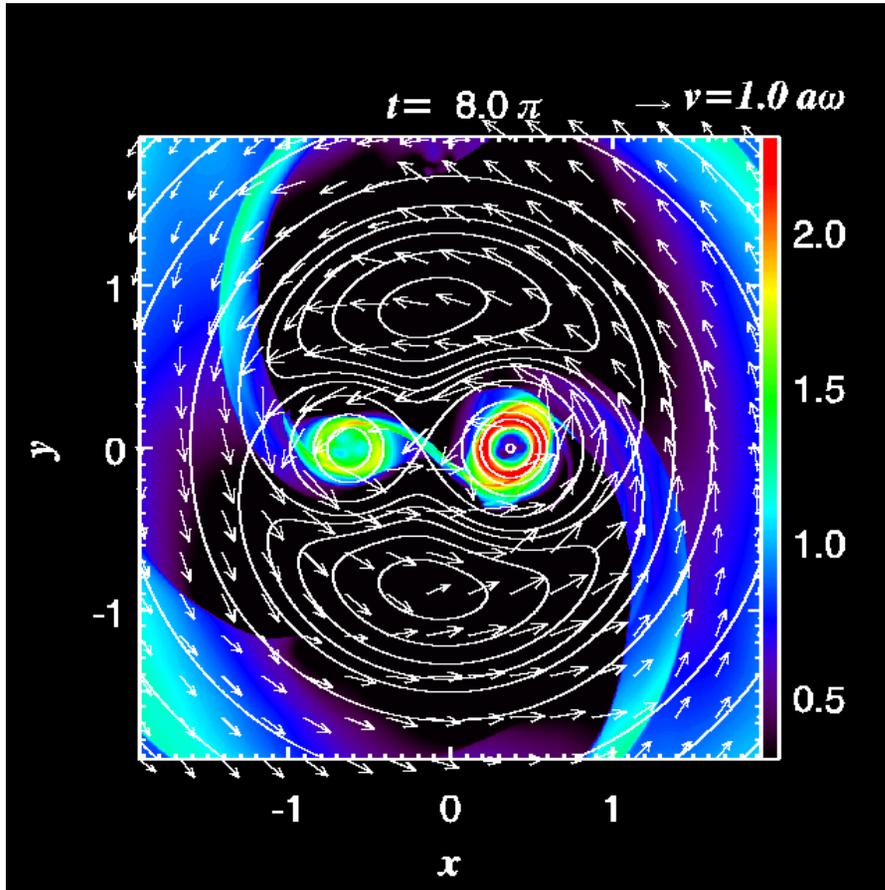
$$q = 0.6, \quad j = 1.6, \quad c_s = 0.25$$



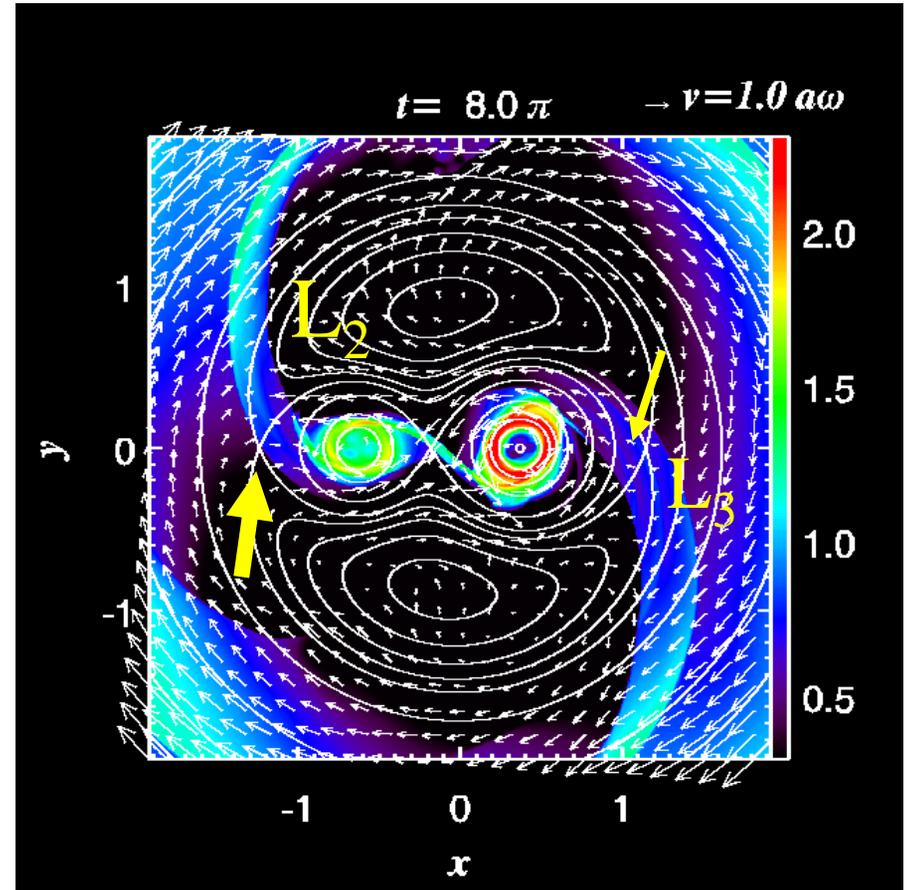
円盤の質量



アクリションは L_2 から

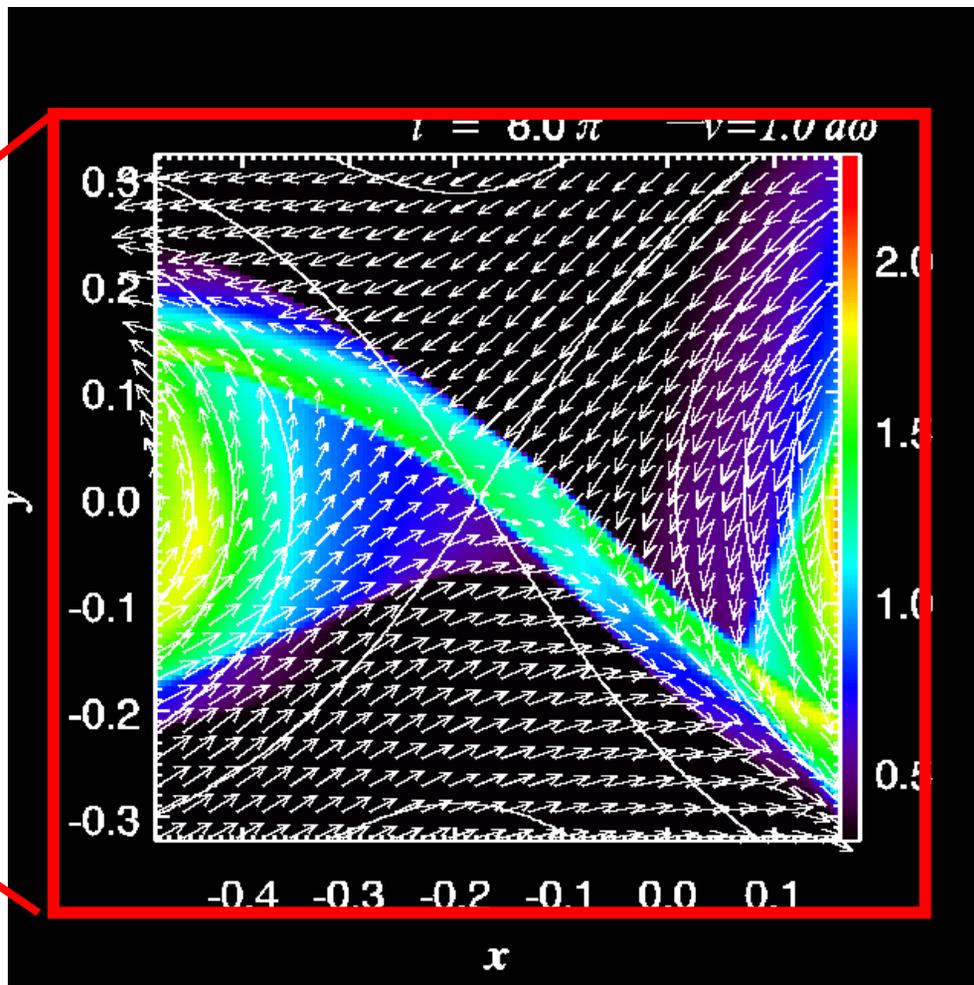
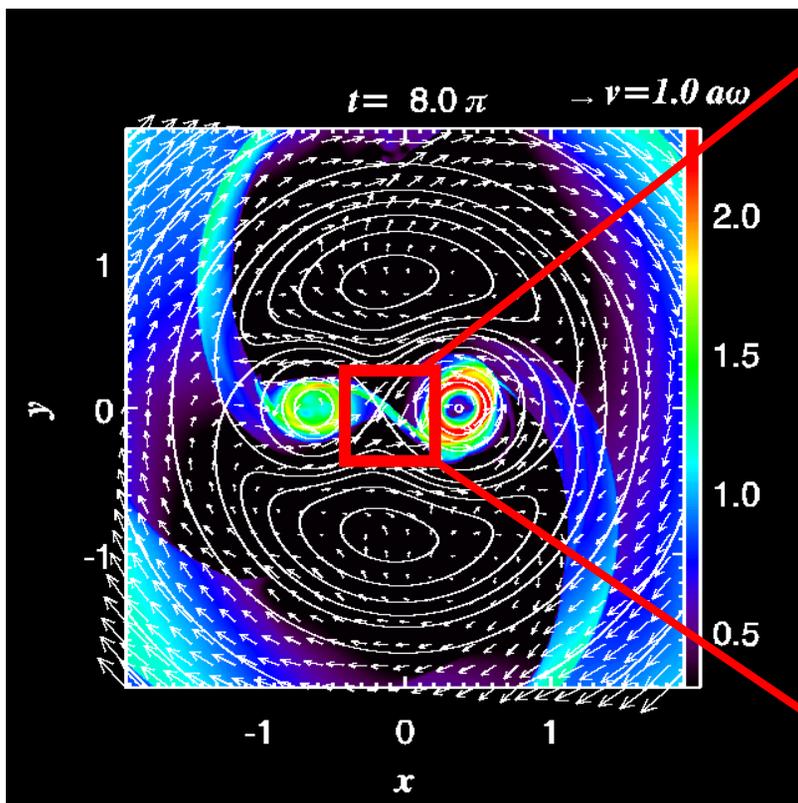


静止系

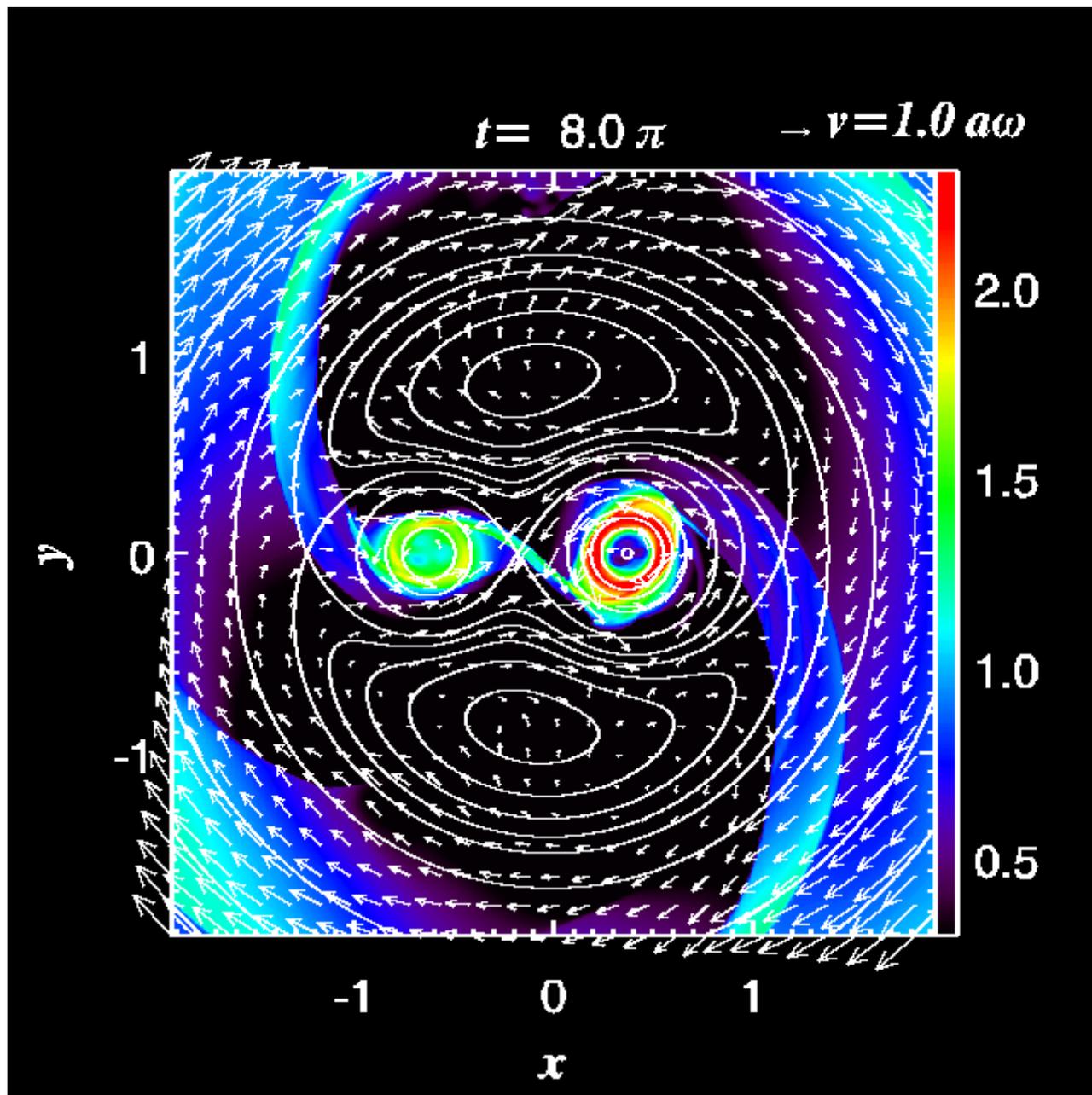


回転系

ガスは L_2 と L_1 を通って主星へ



回轉系



j_{inf} 依存性

$t = 24.0$

($q = 0.6$, $c_s = 0.25$)
 $q =: M_2 / M_1$



$j_{\text{inf}} = 1.3$

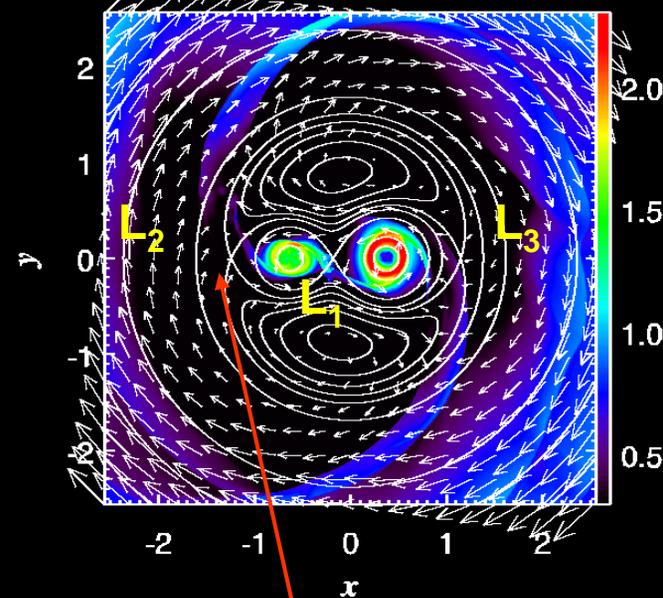
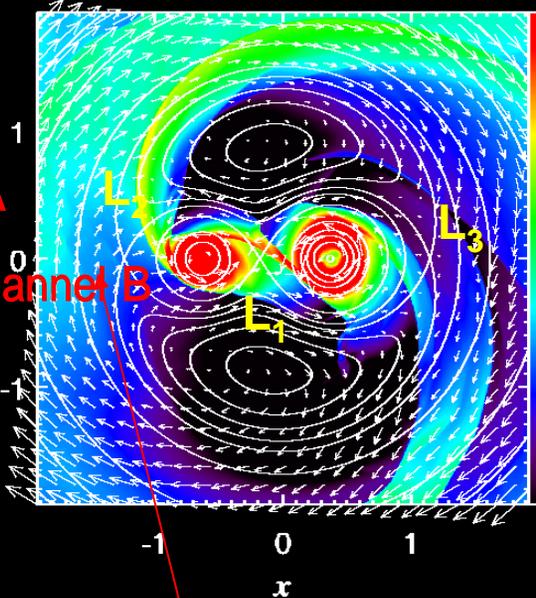
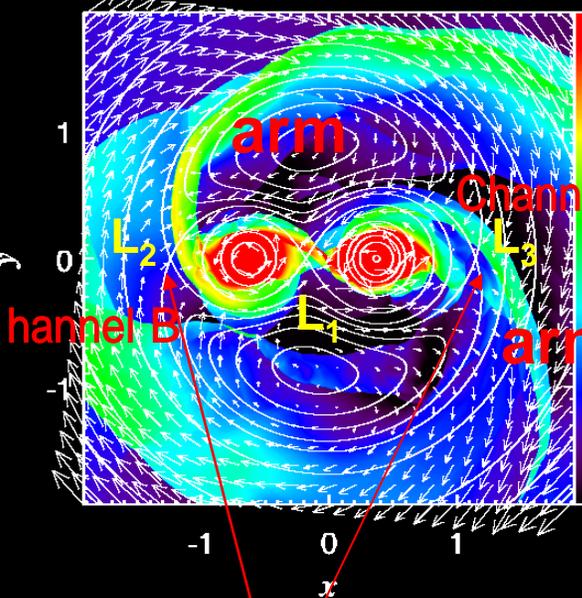
$v = 1.0$

$j_{\text{inf}} = 1.5$

$v = 1.0$

$j_{\text{inf}} = 1.9$

$v = 1.0$



L_2 と L_3 の両方から

主に L_2

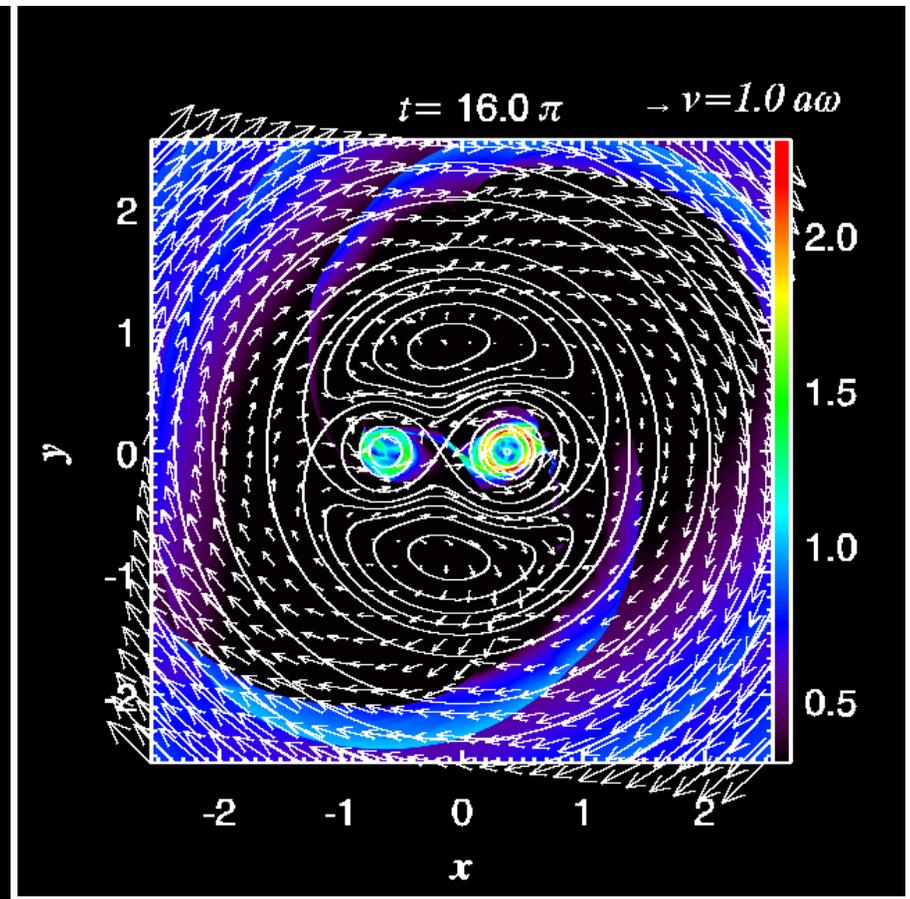
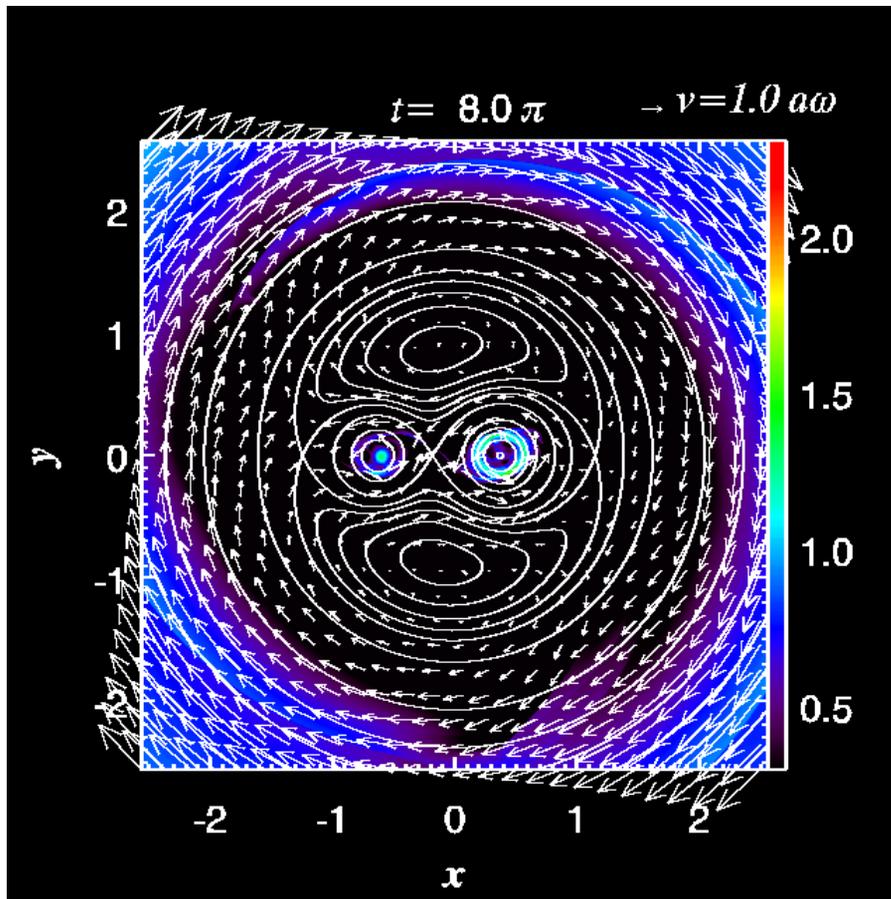
時間がたつと
 L_2 から



$$q = 0.6, \quad j = 1.9, \quad c_s = 0.25$$

$t = 8$

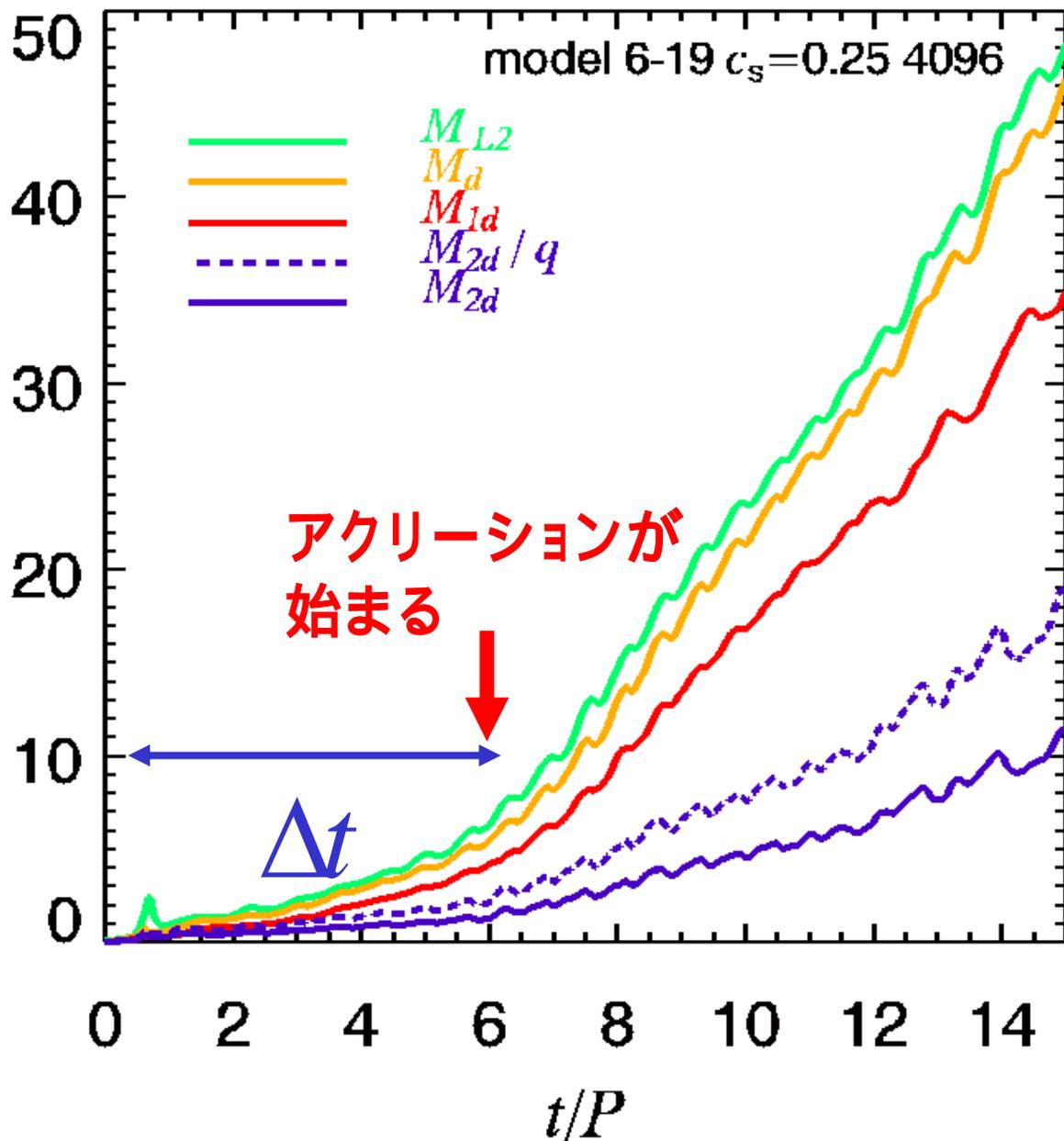
$t = 16$



$$j_{\text{inf}} = 1.9$$

$$\Delta t \propto \frac{j - 1.7}{c_s}$$

M



q 依存性

$t = 22.0$

($j_{\text{inf}} = 1.5$, $c_s = 0.25$)

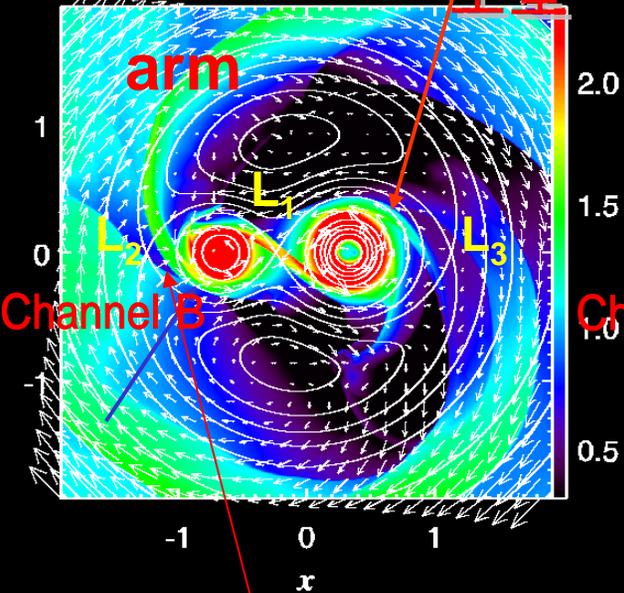


$q = 0.5$

主星

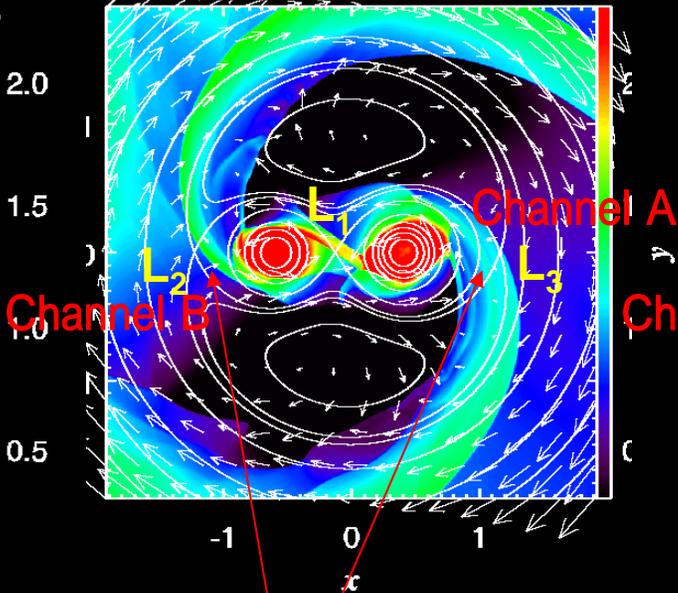
ω

arm



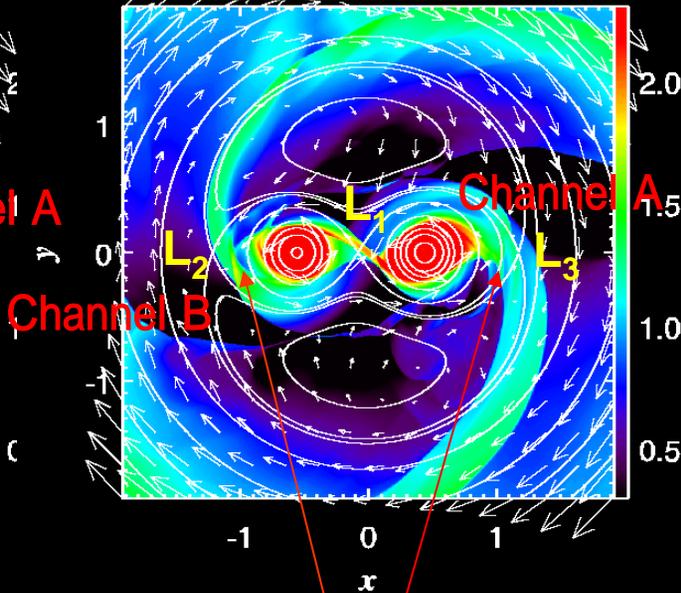
$q = 0.7$

$v = 1.0 c$



$q = 0.8$

$v = 1.0 \omega$



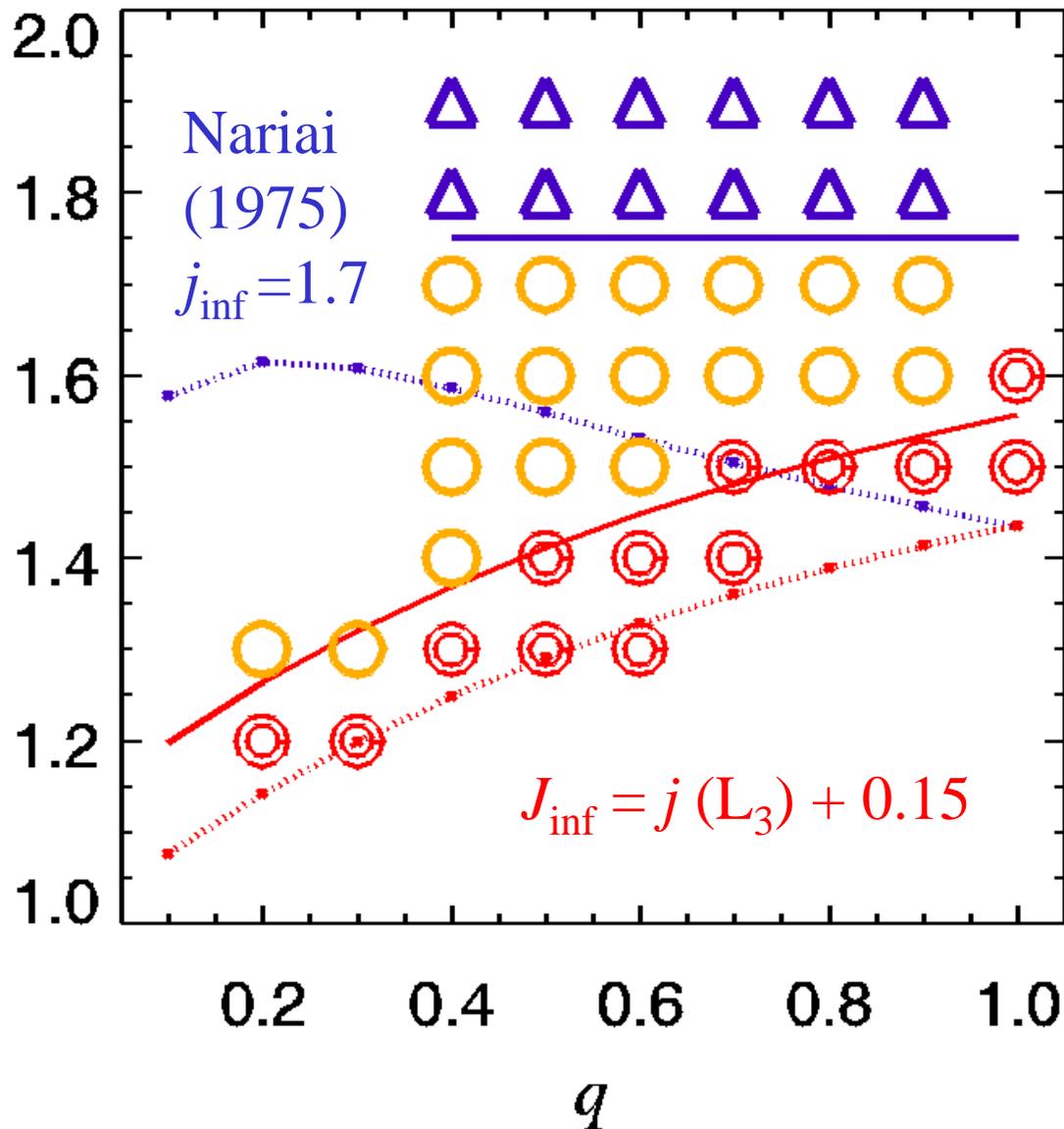
主に L_2 より

L_2 と L_3 の両方より
星周円盤は楕円形

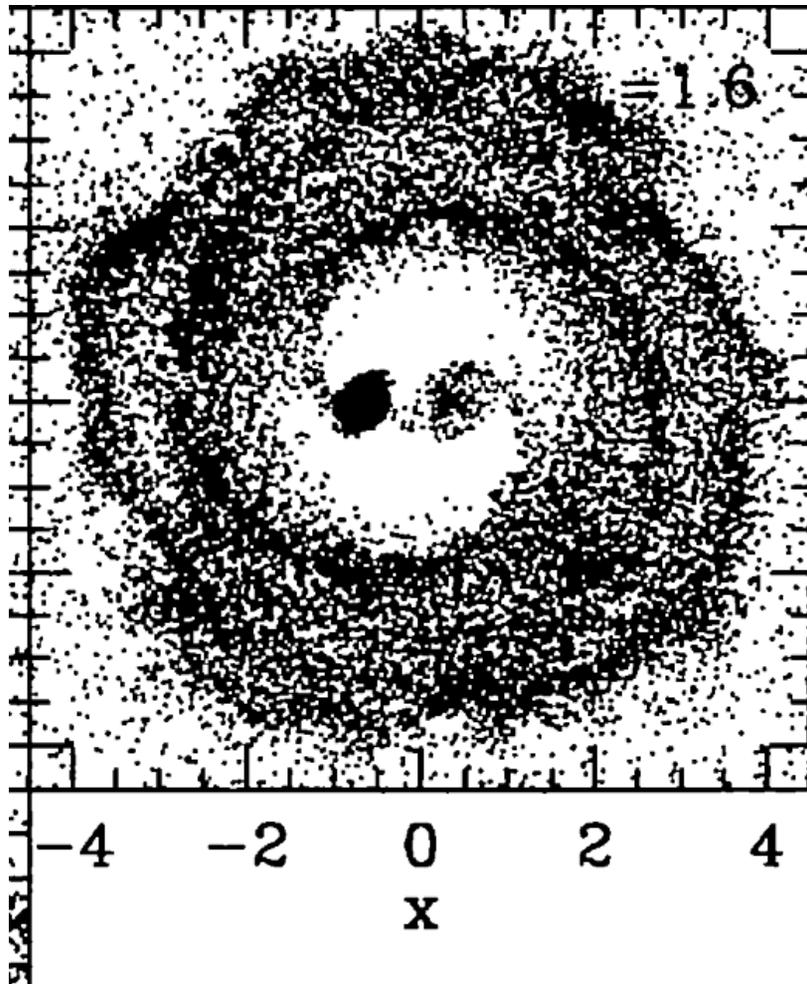


3タイプのアクリーション

- 時間が経過したのち L_2 より
- 主に L_2 より
- L_2 と L_3 の両方から



Bate & Bonnell (1997)との比較



3D SPH simulation

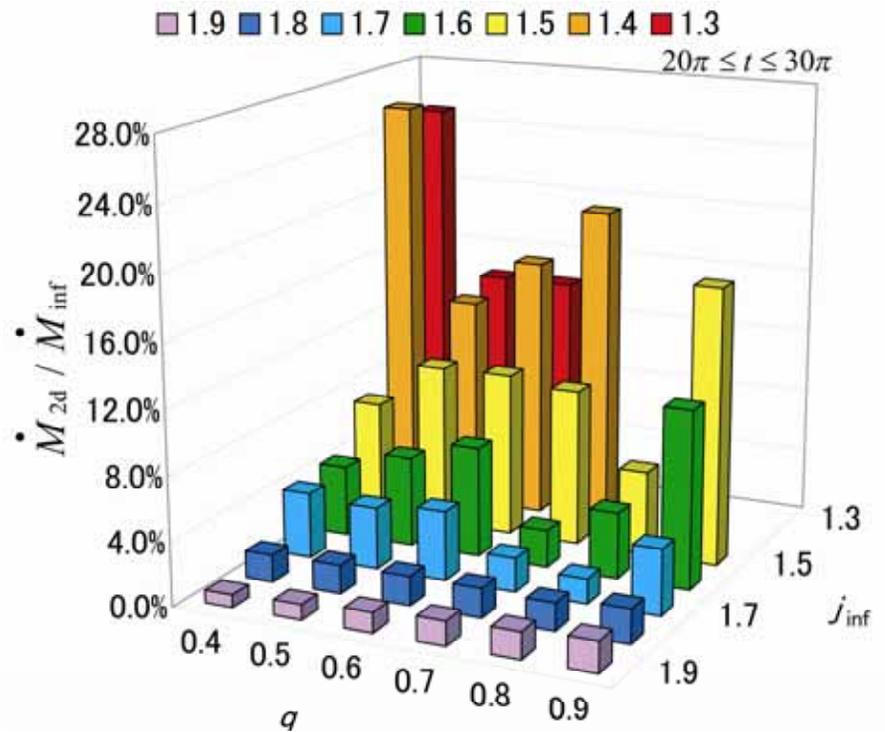
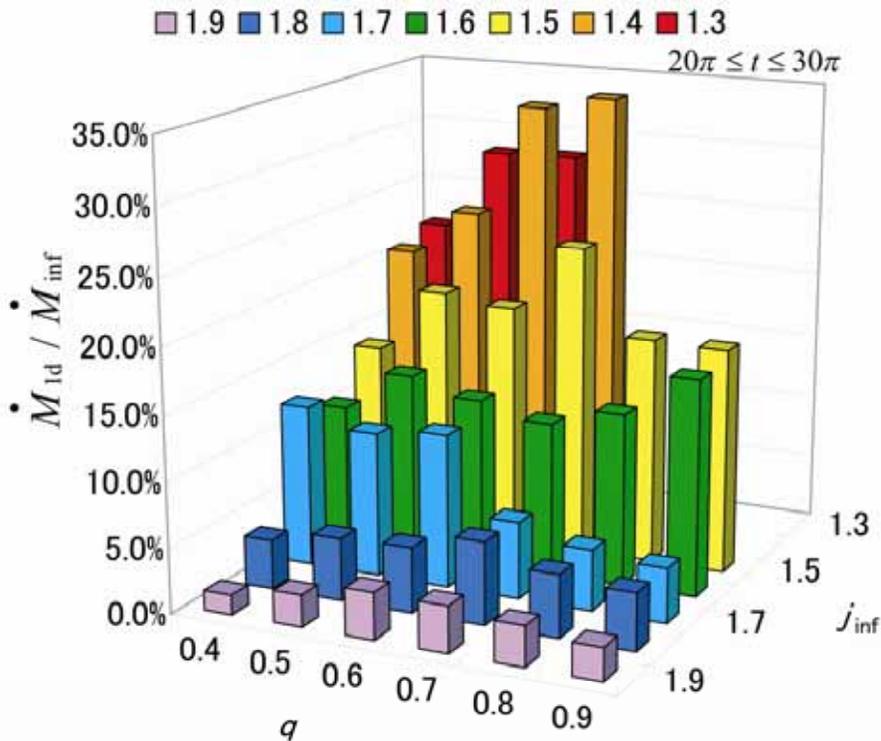
渦状衝撃波

L_2 から降着

直接伴星へ

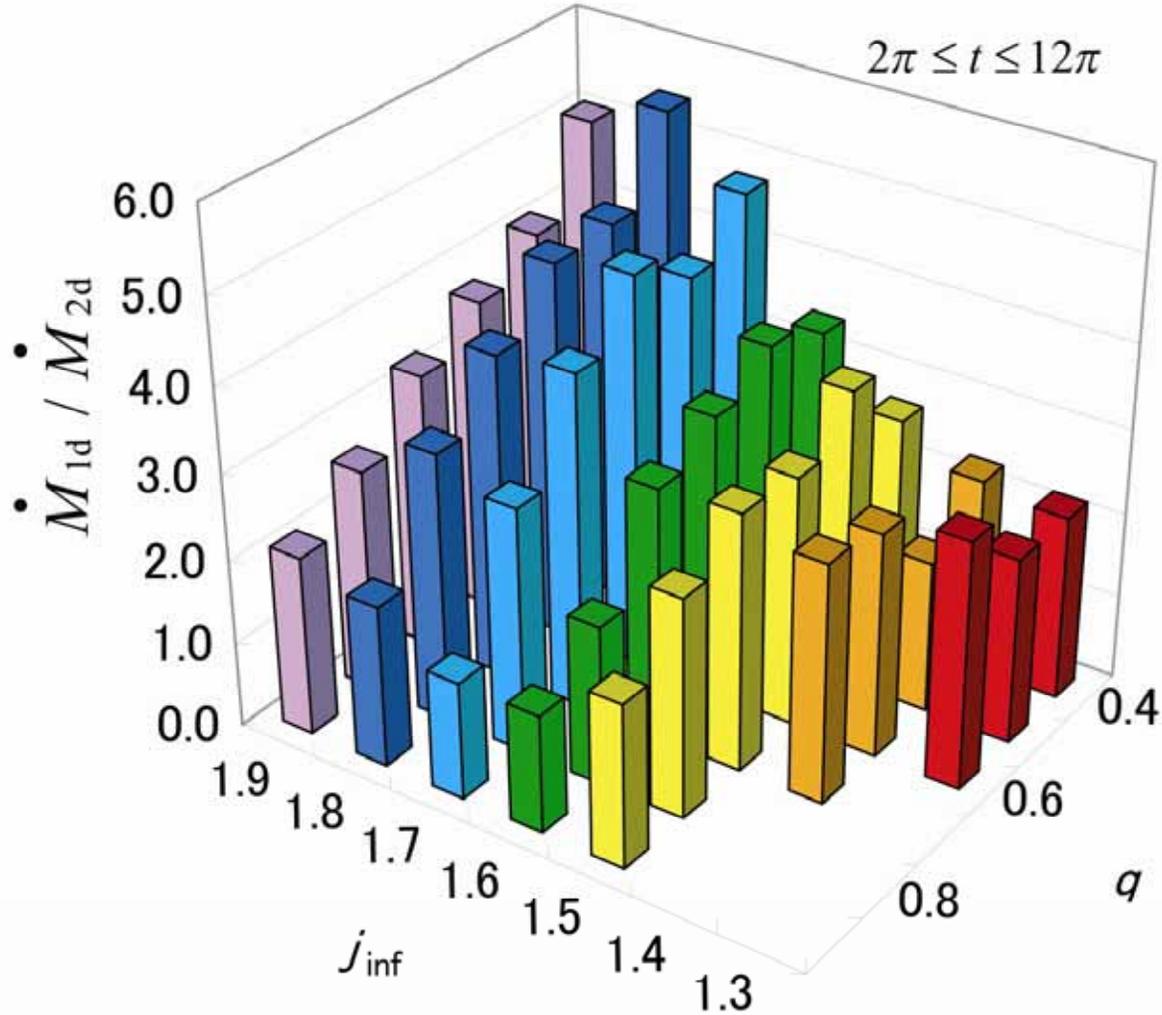
数値粘性が大きすぎる!

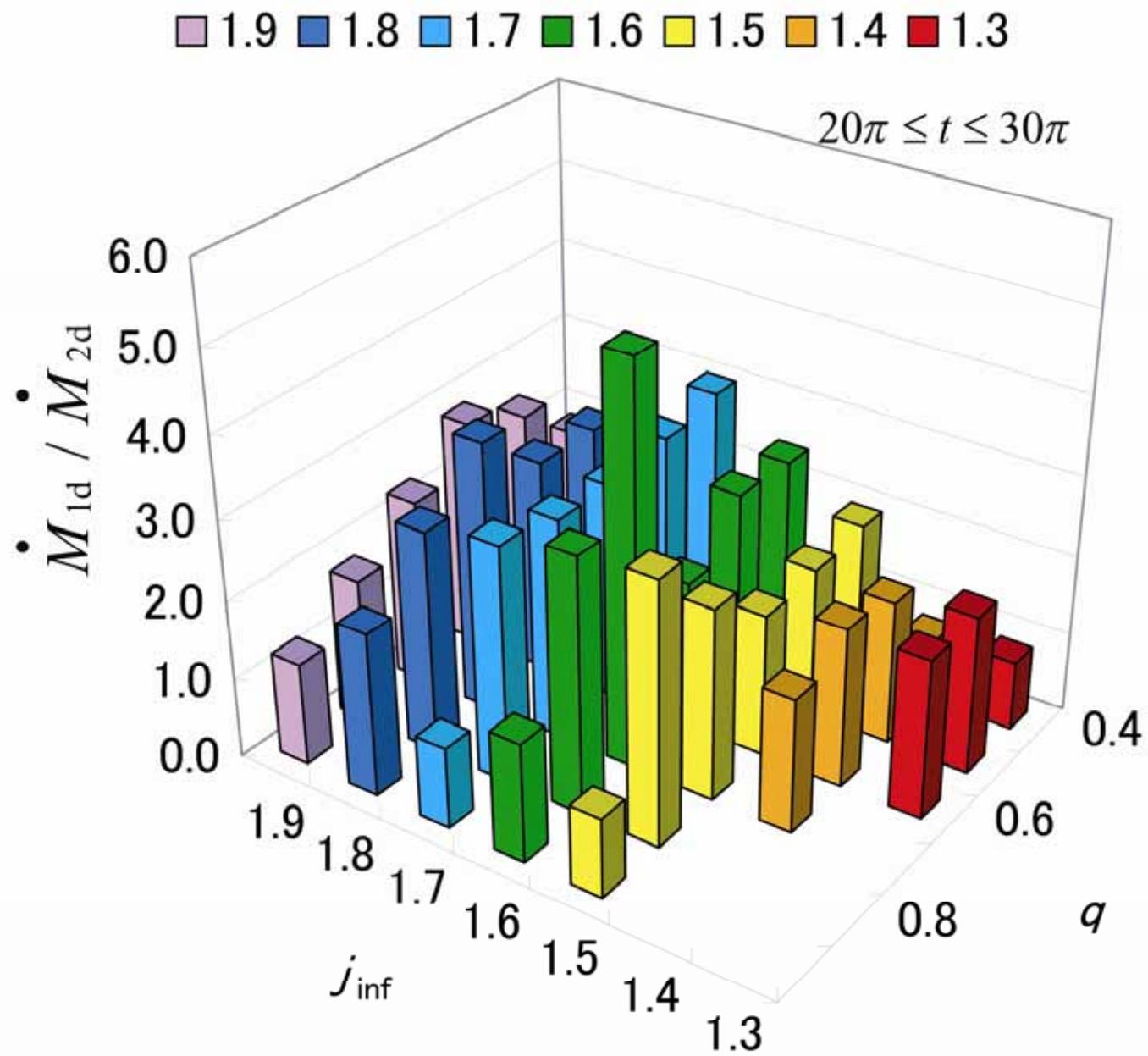
$$dM_1/dt > dM_2/dt$$



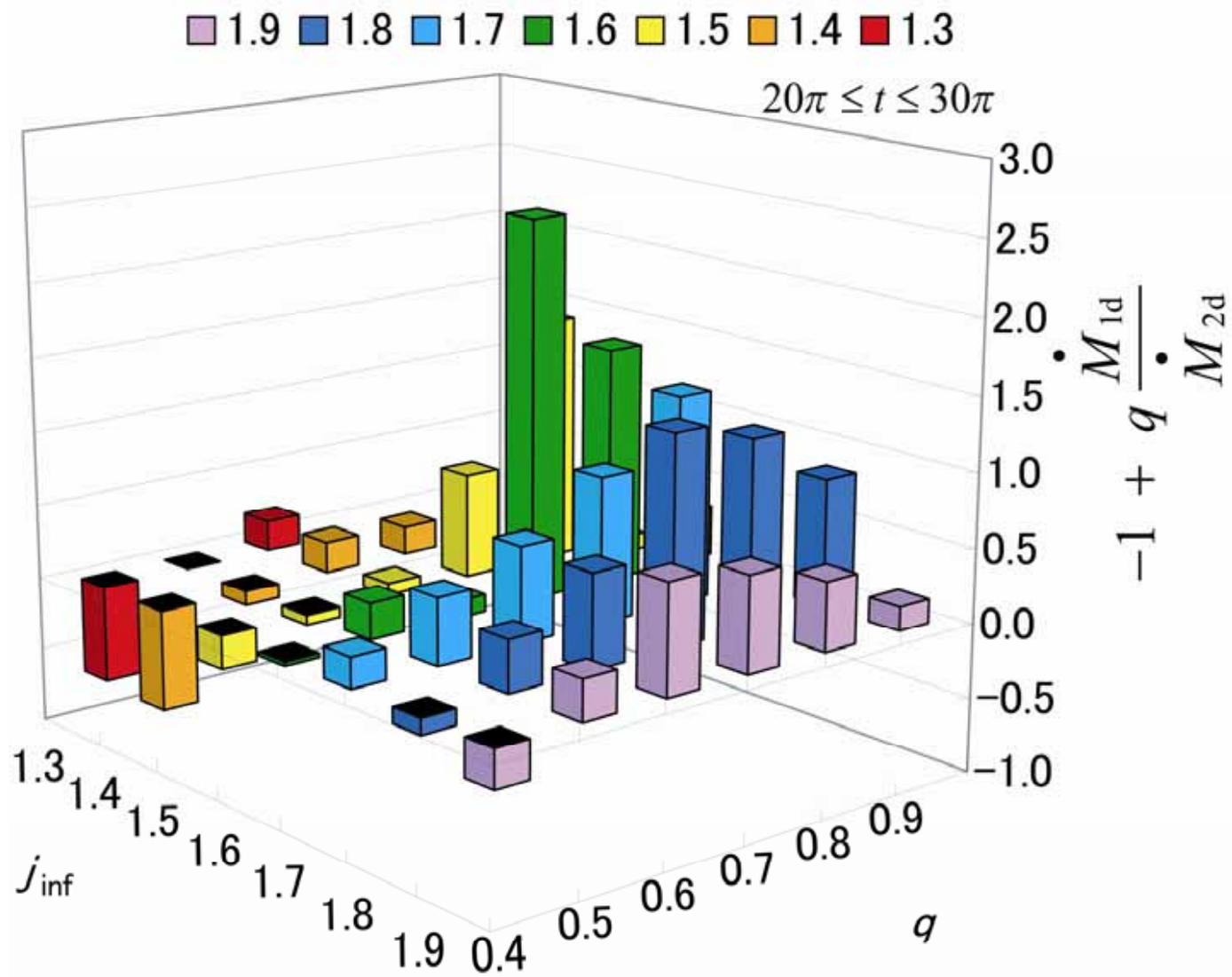
質量降着量の比

■ 1.9 ■ 1.8 ■ 1.7 ■ 1.6 ■ 1.5 ■ 1.4 ■ 1.3

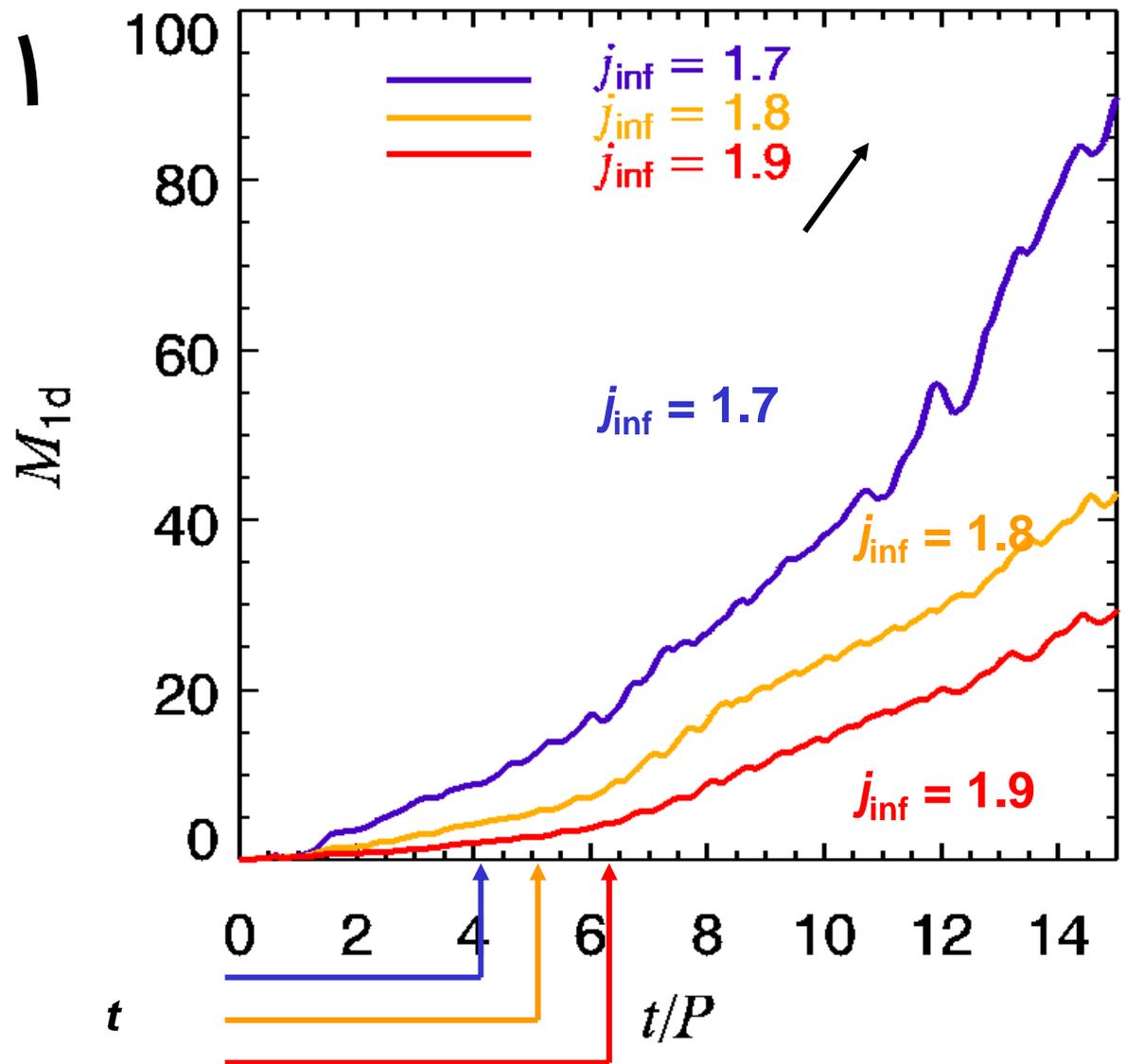




dq/dt (質量比の進化)



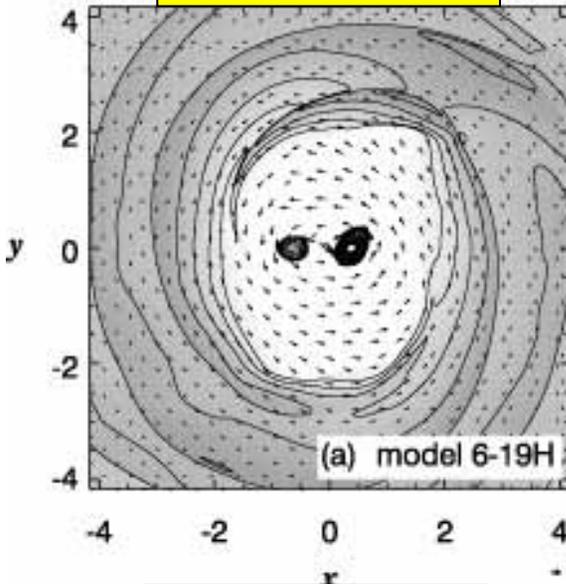
j_{inf} が大きい
ほど休止期
が長い



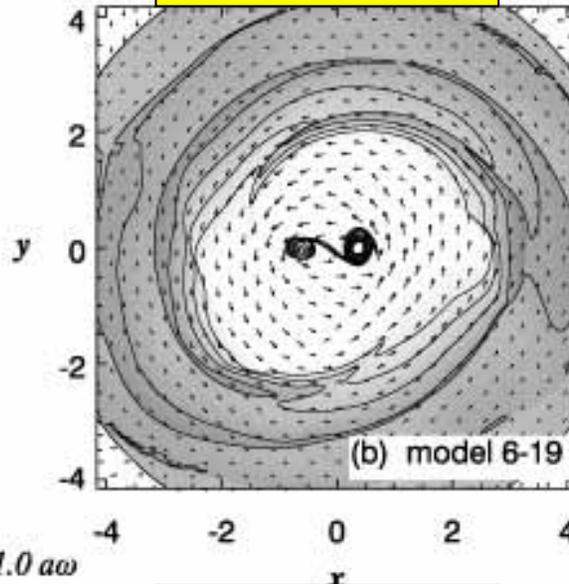
($q = 0.6, c_s = 0.25$)

温度依存性

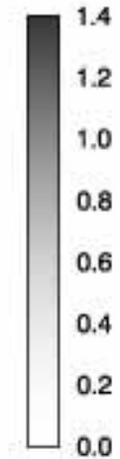
$c_s = 0.30$



$c_s = 0.25$



$\log_{10} \Sigma$

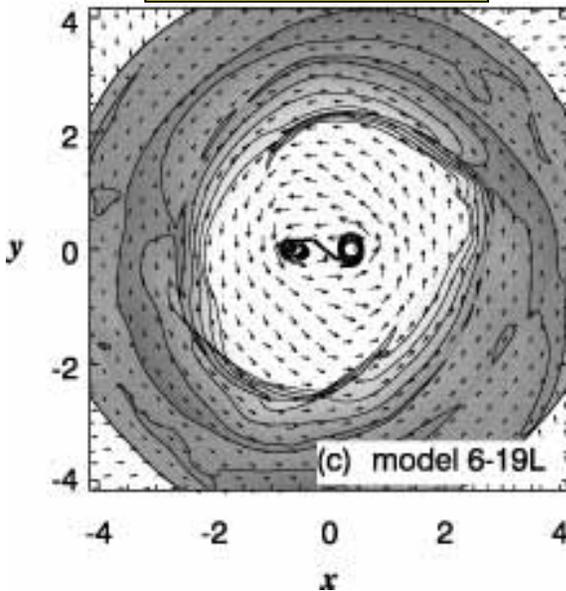


$q = 0.6$

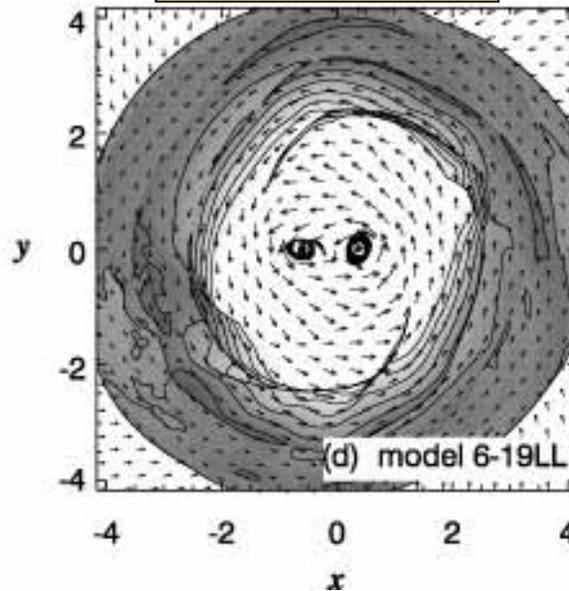
$j_{\text{inf}} = 1.9$

$t = 10.0$

$c_s = 0.20$



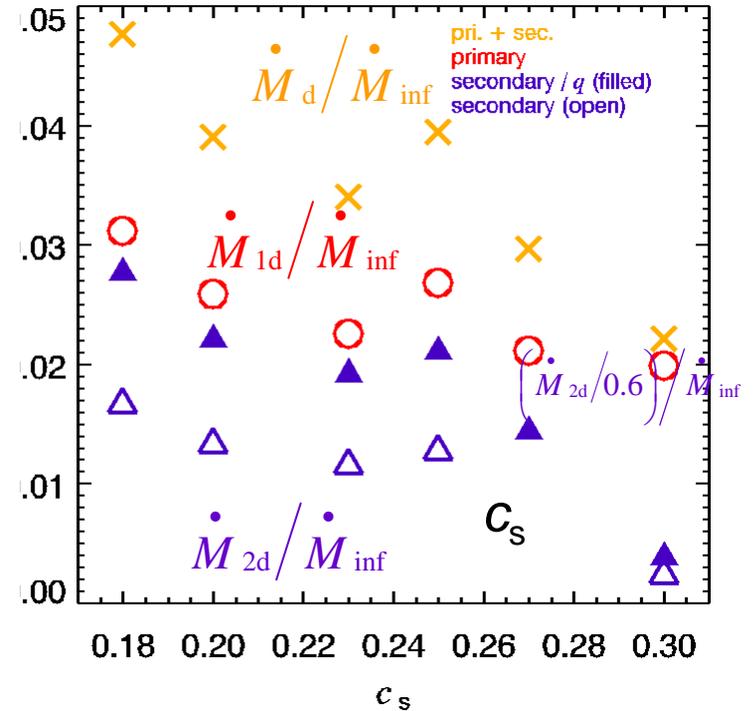
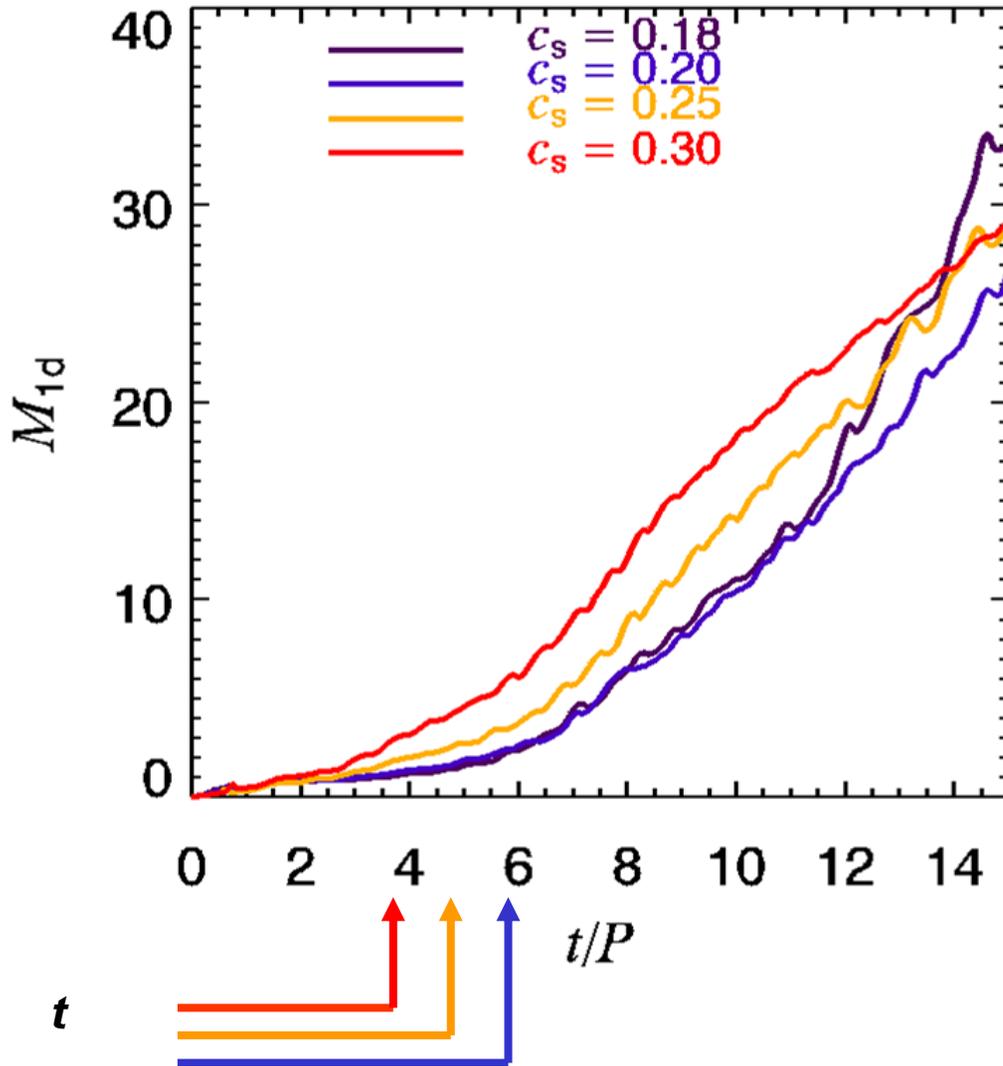
$c_s = 0.18$



When C_s is smaller, gap is wider and spiral arms are more tight.

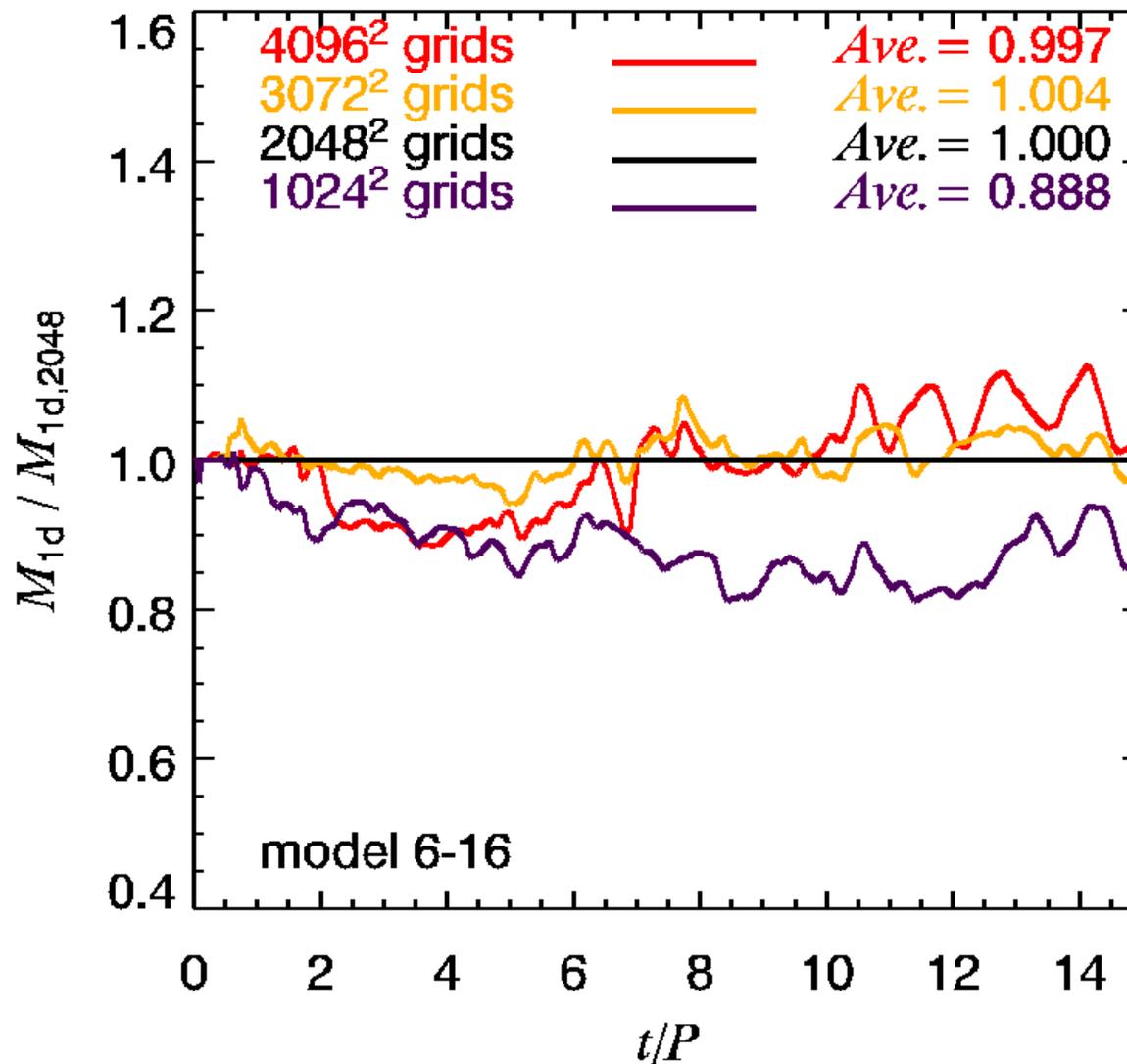
温度依存性 (つづき)

$$16\pi \leq t \leq 26\pi$$

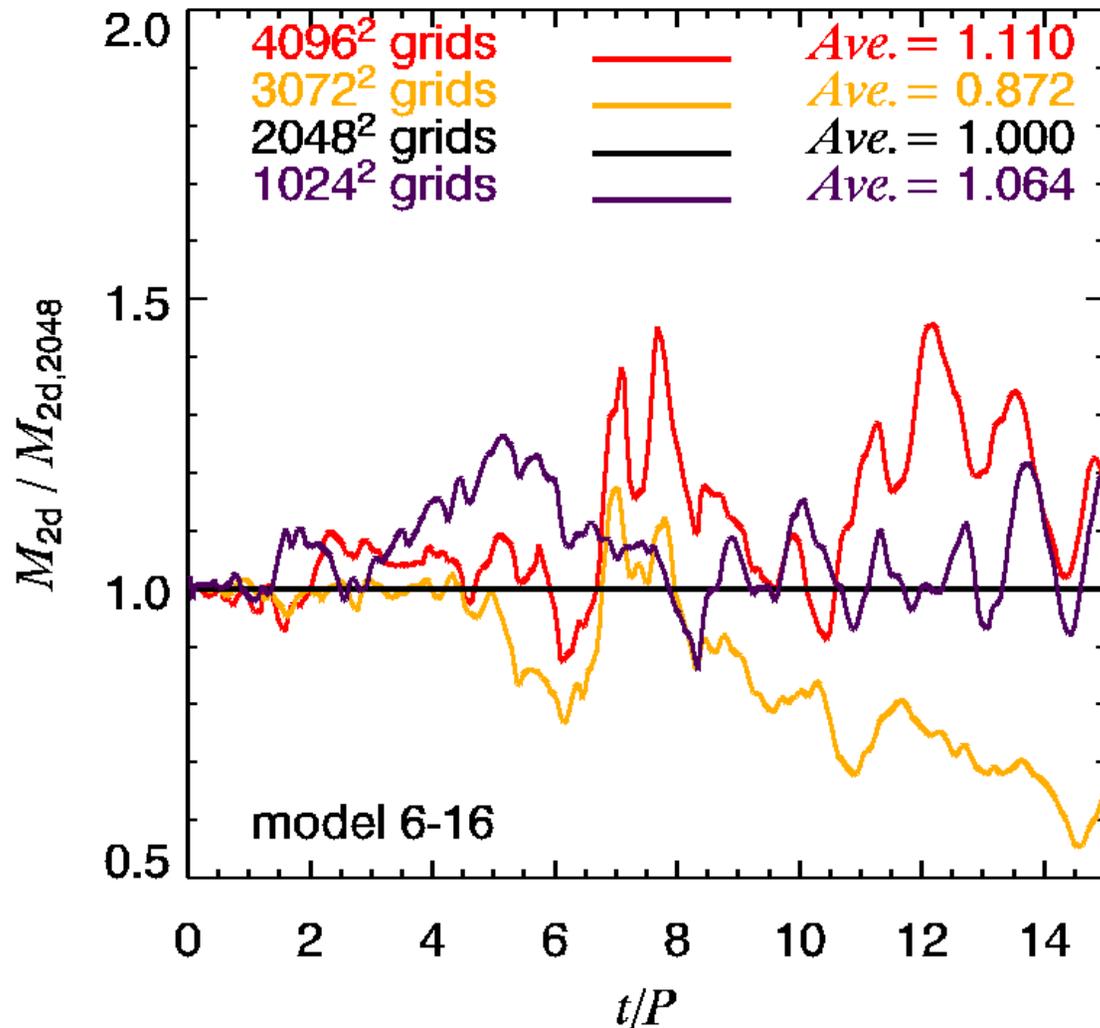


$$(q = 0.6, j_{inf} = 1.9)$$

収束の確認と安定性



収束の確認と安定性(つづき)



まとめ

- 2つの経路で連星へ降着: L_2 (主) L_3 (副).
- 主星のほうが質量降着率が高い (L_1 からガスが流れ込む). $\dot{M}_1 > \dot{M}_2$
- (多くのモデルでは)質量比が下がる。
- ガス降着には速い成分と遅い成分がある。速い成分は重力トルクによる。遅い成分は渦状衝撃波による。
- $j > 1.75$ では遅い成分だけ。