

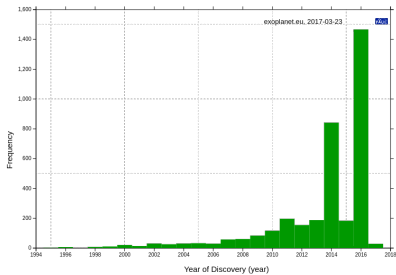
Hot Jupiters' Oprindelse

Maria Hjorth
Stellar Astrophysics Centre
hjorth@phys.au.dk



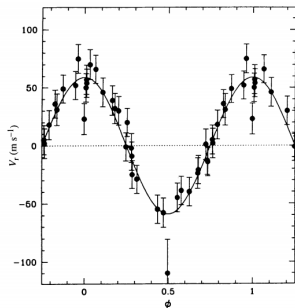
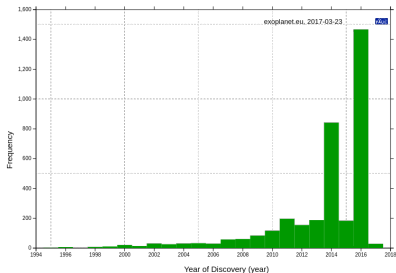
Exoplaneter

- 23/3 2017: 3603



Exoplaneter

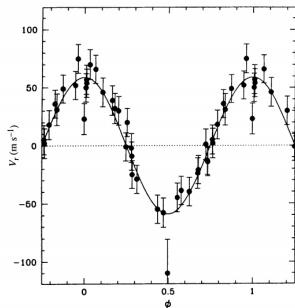
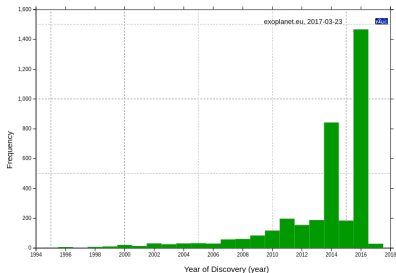
- 23/3 2017: 3603
- Mayor & Queloz 1995:
51 Peg b



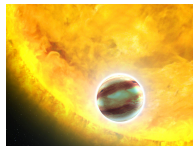
Figur: Mayor & Queloz (1995)

Exoplaneter

- 23/3 2017: 3603
- Mayor & Queloz 1995:
51 Peg b
- Hot Jupiters: ~ 200

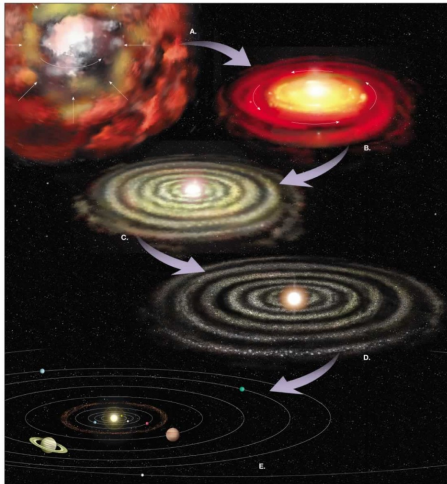


Figur: Mayor & Queloz (1995)



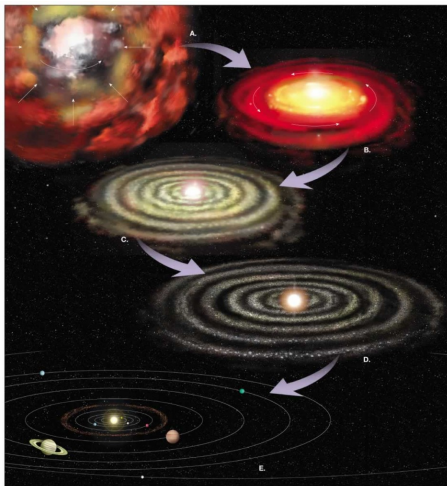
Figur: NASA

Planetdannelse



Figur: plymouth.edu

Planetdannelse



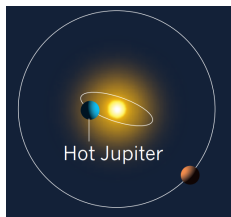
Figur: plymouth.edu



Figur: NASA



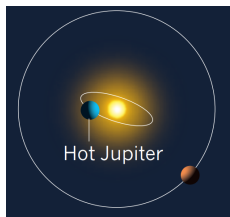
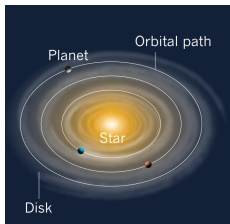
Migration



Figurer: Triaud (2016)

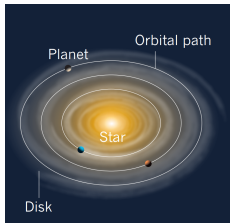
Migration

Disk:

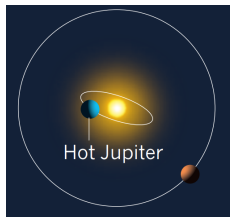
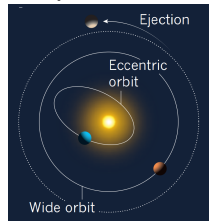


Migration

Disk:

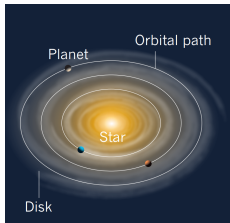


Dynamik:

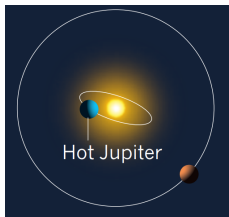
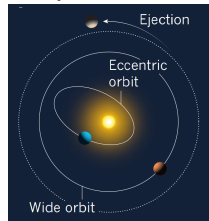


Migration

Disk:

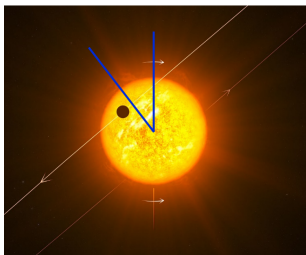


Dynamik:



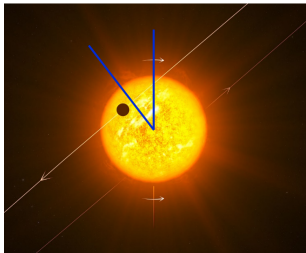
Figurer: Triaud (2016)

Oblikviteter: Dynamisk Migration

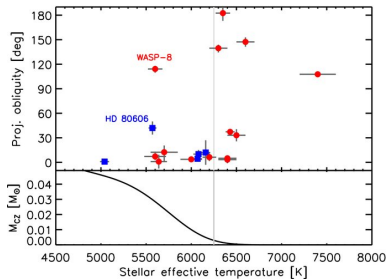


Figur: ESO

Oblikviteter: Dynamisk Migration

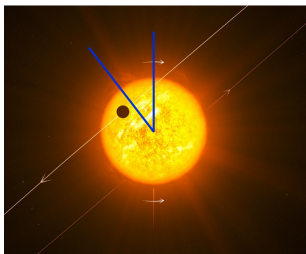


Figur: ESO

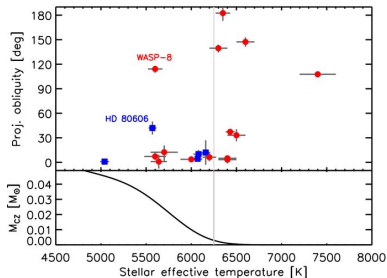


Figur: Winn et al. (2010)

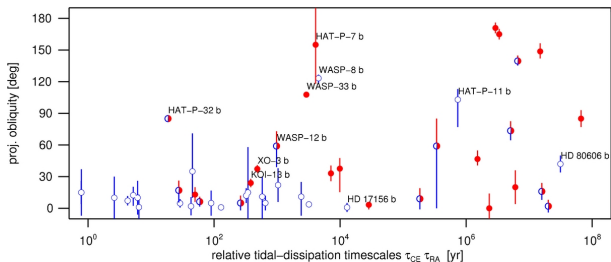
Oblikviteter: Dynamisk Migration



Figur: ESO

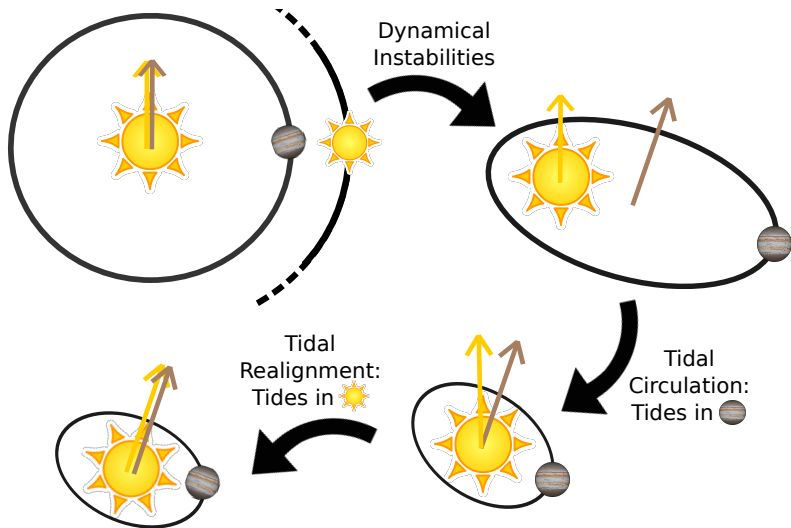


Figur: Winn et al. (2010)

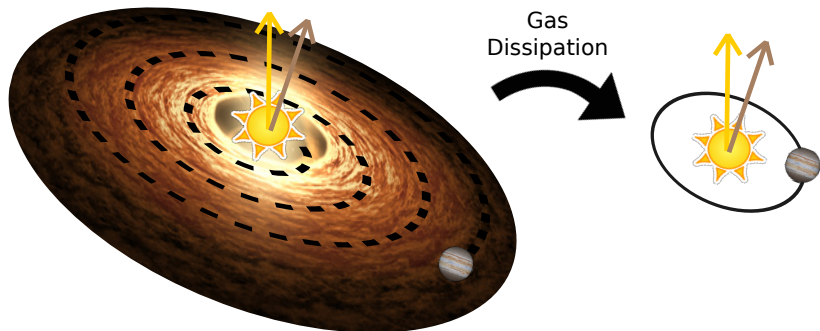


Figur: Albrecht et al. (2012)

Oblikviteter: Dynamisk Migration

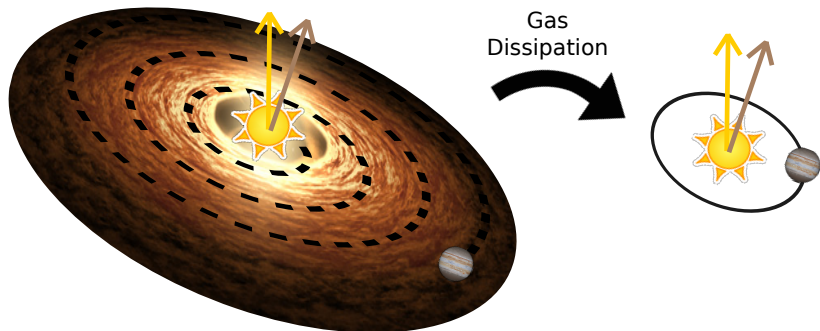


Skrå disk: Disk Migration



Figur: NASA (disk)

Skrå disk: Disk Migration

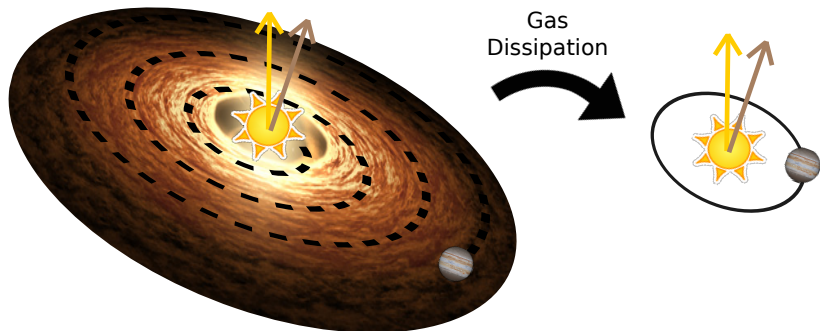


Figur: NASA (disk)

Eksempler på mekanismer:

- Kaotisk stjernedannelse (Bate et al. (2010)).
- Dobbeltstjernesystem (Batygin (2012)).

Skrå disk: Disk Migration

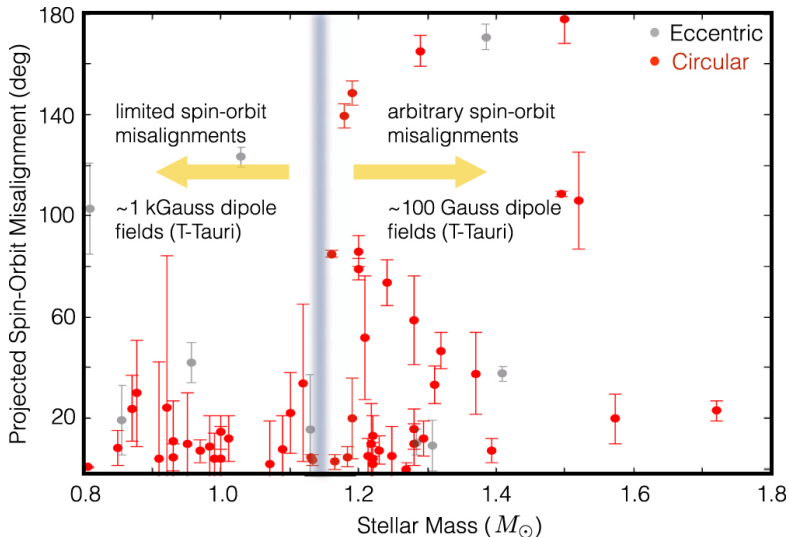


Figur: NASA (disk)

Eksempler på mekanismer:

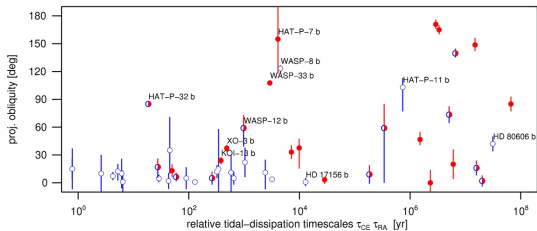
- Kaotisk stjernedannelse (Bate et al. (2010)).
- Dobbeltstjernesystem (Batygin (2012)).
- Stjernens magnetfelt (Lai et al. (2011), Spalding & Batygin (2015)).

Skrå disk: Disk Migration

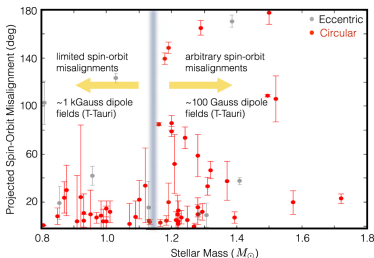


Figur: Spalding & Batygin (2015)

Dynamik eller Disk?



Figur: Albrecht et al. (2012)



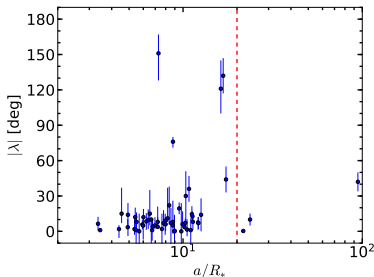
Figur: Spalding & Batygin (2015)



Løsning: Warm Jupiters

Dynamik:

- Zahn (1977): $\tau \propto \left(\frac{a}{R_*}\right)^6$
- Warm Jupiters: $0 - 180^\circ$



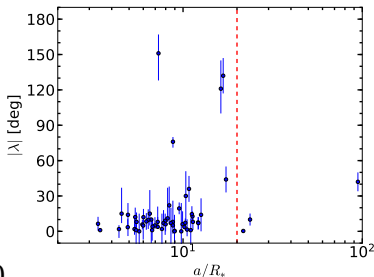
Løsning: Warm Jupiters

Dynamik:

- Zahn (1977): $\tau \propto \left(\frac{a}{R_*}\right)^6$
- Warm Jupiters: $0 - 180^\circ$

Disk:

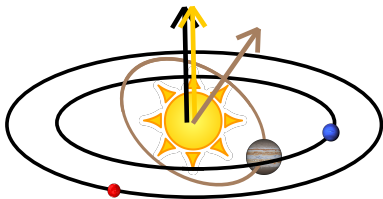
- Spalding og Batygin (2015):
Kun indre disk skrå: $\frac{a}{R_*} \lesssim 20$
- Warm Jupiters: $\sim 0^\circ$



Løsning: Multiplanetsystemer

Dynamik:

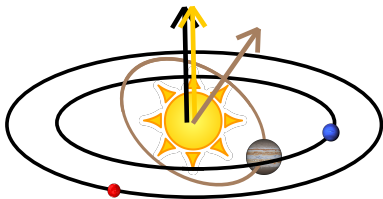
- Hot Jupiter: $0 - 180^\circ$
- Andre planeter: $\sim 0^\circ$



Løsning: Multiplanetsystemer

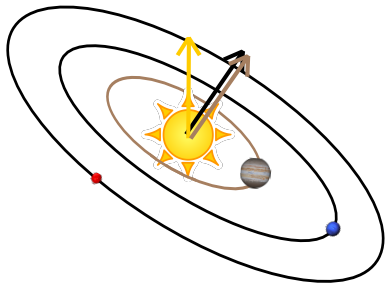
Dynamik:

- Hot Jupiter: $0 - 180^\circ$
- Andre planeter: $\sim 0^\circ$



Disk:


- Hot Jupiter: $0 - 180^\circ$
- Indre planeter:
samme som Hot Jupiter



Fremtid

Flere observationer:

- Multiplanetsystemer
- Warm Jupiters



European Organisation for Astronomical Research in the Southern Hemisphere

OBSEVING PROPOSAL PERIODS • Multi-Observer Applications • 2 • 20-2017 (starting 01 October) • 2017 • 2018-2019 • 2019 • 2020-2021

APPLICATION FOR OBSERVING TIME

Important Notice:
By submitting this proposal, the PI takes full responsibility for the content of the proposal, in particular with regard to the names of CoIs and the agreement to act according to the ESO policy and regulations. Should observing time be granted:

PERIOD: 99A

Category: C-7

1. Title
Towards a better understanding of Hot Jupiter formation: Orbital measurements of key systems

2. Abstract / Total Time Requested
Total Amount of Time: 1 night VM, 11 hours SM
Emphasize science has been full of surprises, especially in the area of this field. The existence of hot Jupiters having orbital distances much smaller than an astronomical unit (AU). It is thought that giant planets may only form at distances of several AU from their host stars. Past and present observations have been inconsistent with

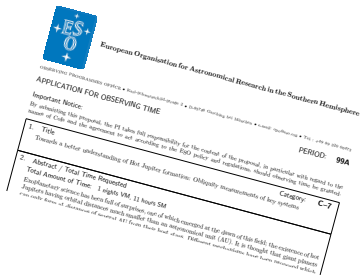
Fremtid

Flere observationer:

- Multiplanetsystemer
- Warm Jupiters

Bedre Dataanalyse:

- Genanalyse data
- Nye metoder



Fremtid

Flere observationer:

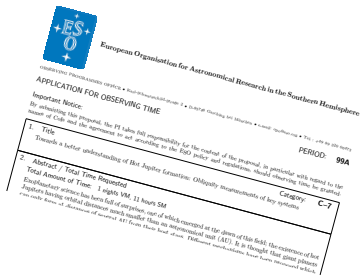
- Multiplanetsystemer
- Warm Jupiters

Bedre Dataanalyse:

- Genanalyse data
- Nye metoder

Nye teleskoper:

- ESPRESSO
- TESS, PLATO



Konklusion

- Dannelse: migration.
- Disk eller dynamik??
- Hældning ml. stjerne og bane: dynamik
..men: Skrå disk?
- Svar: Multiplanetsystemer og Warm Jupiters.
- Fremtiden: Flere observationer, bedre dataanalyse og nye teleskoper.

Spørgsmål?