



Kinematic Components in Galaxies: Galaxy dynamics & stellar populations NGC 4550



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COSPATIAL COUNTERROTATING STELLAR DISKS IN THE VIRGO E7/S0 GALAXY NGC 4550

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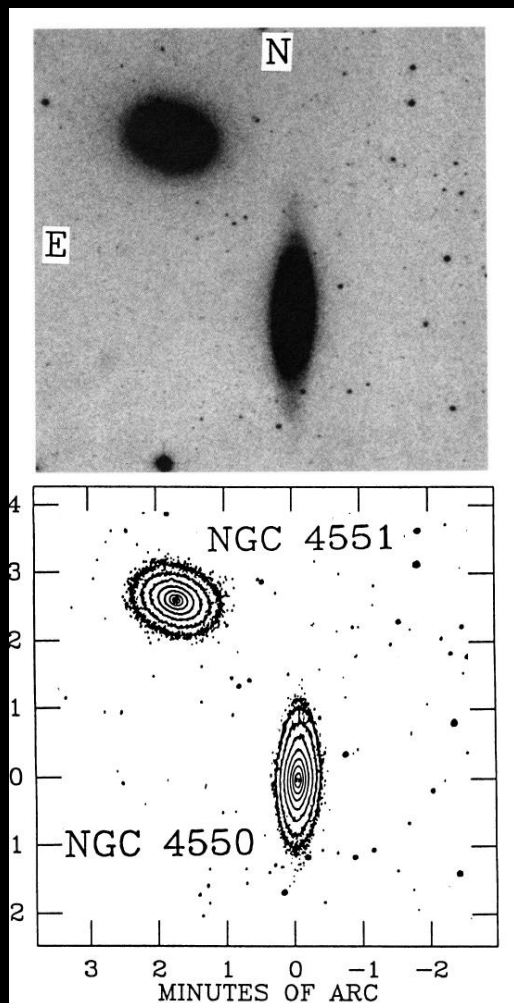
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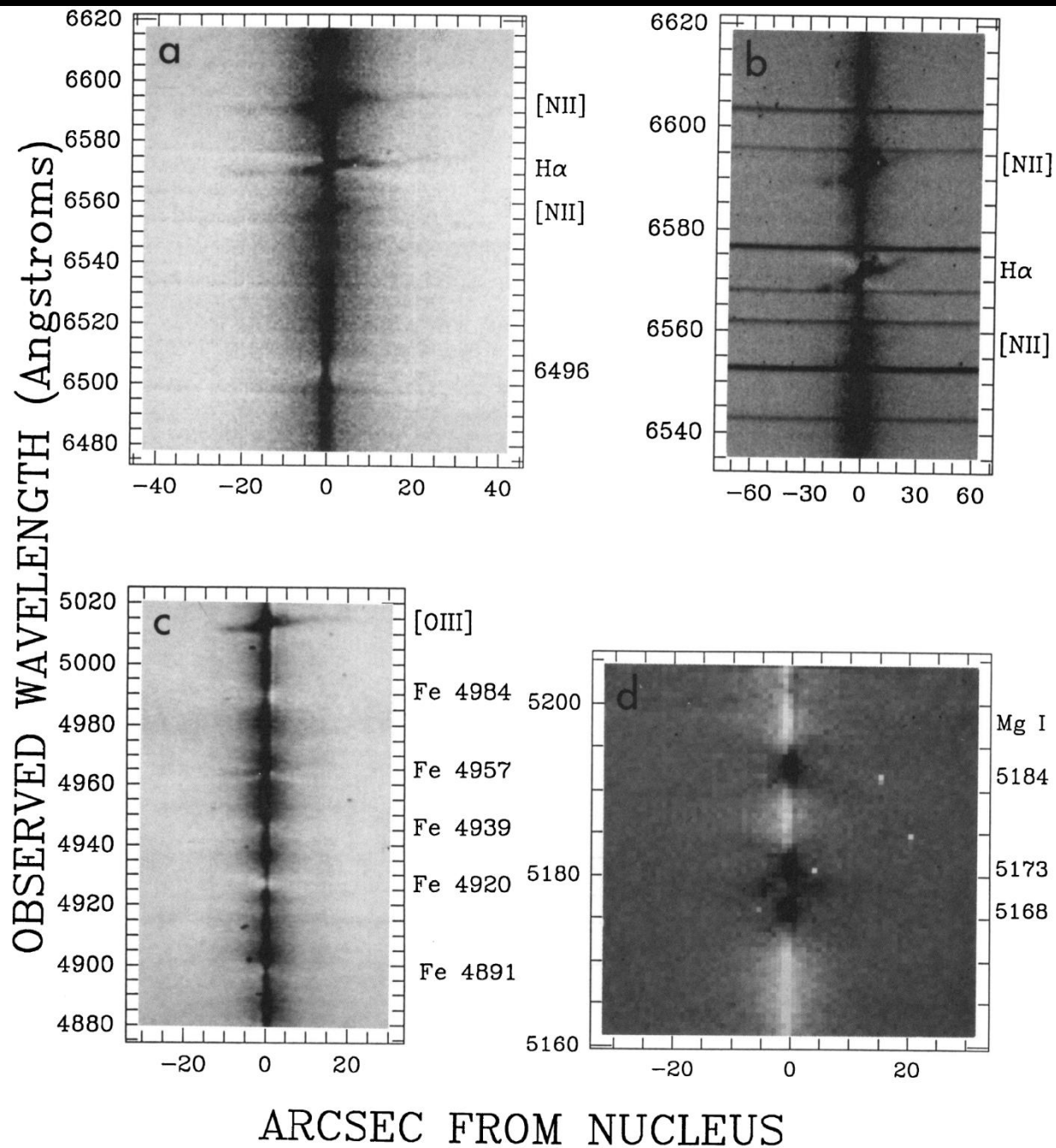
ABSTRACT

We have discovered two cospatial stellar disks, one orbiting prograde, one orbiting retrograde, in NGC 4550, an E7/S0 galaxy in the core of the Virgo Cluster. One of the stellar disks is coincident with a gas disk. Absorption and emission-line velocities for the two counterrotating components have been measured over about one-third of the optical diameter (30"). We propose that after the initial stellar disk of NGC 4550 was formed, a substantial amount of counterrotating gas was acquired $\geq 10^9$ yr ago. It then settled to the plane via dissipation; the bulk of the counterrotating stars most likely formed after the gas settled to the plane.

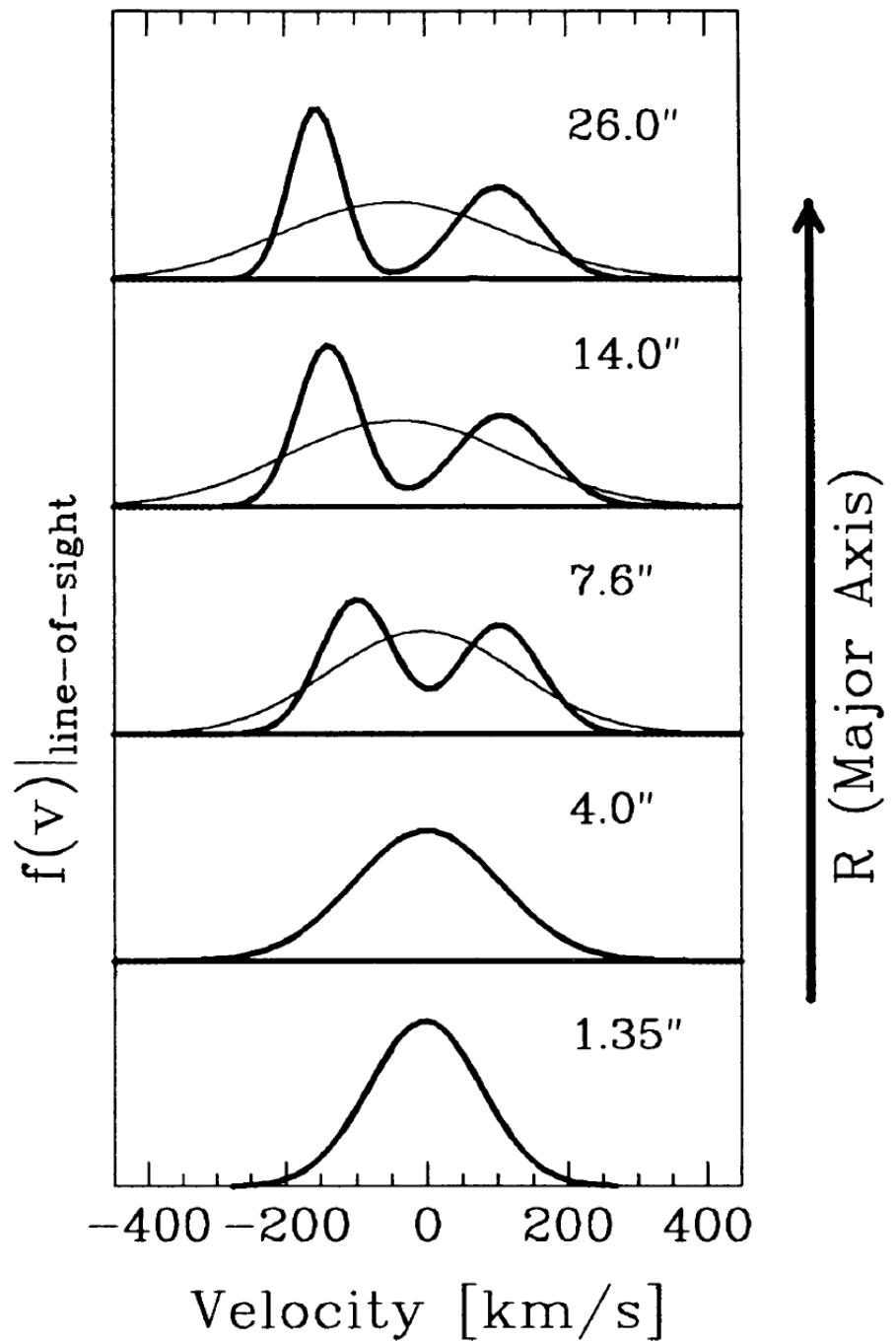
Subject headings: galaxies: clustering — galaxies: elliptical and lenticular, cD — galaxies: kinematics and dynamics



Rubin et al. 1992

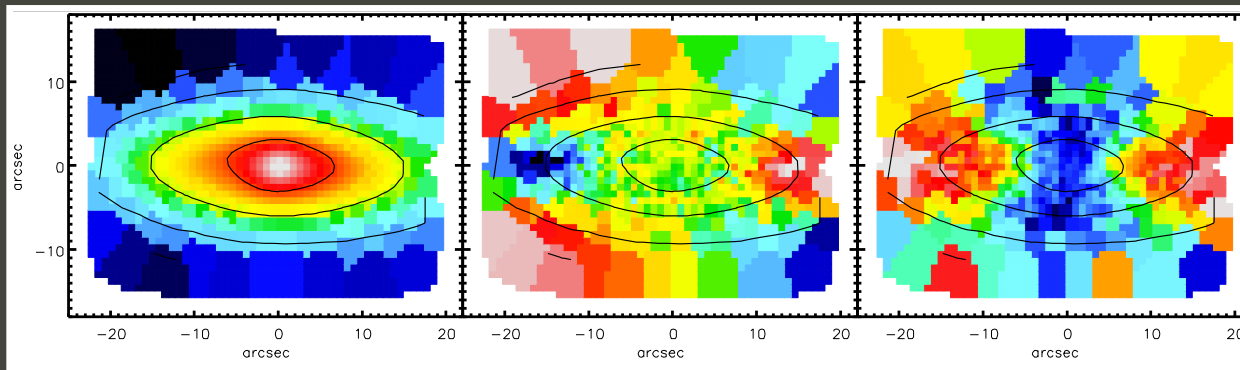
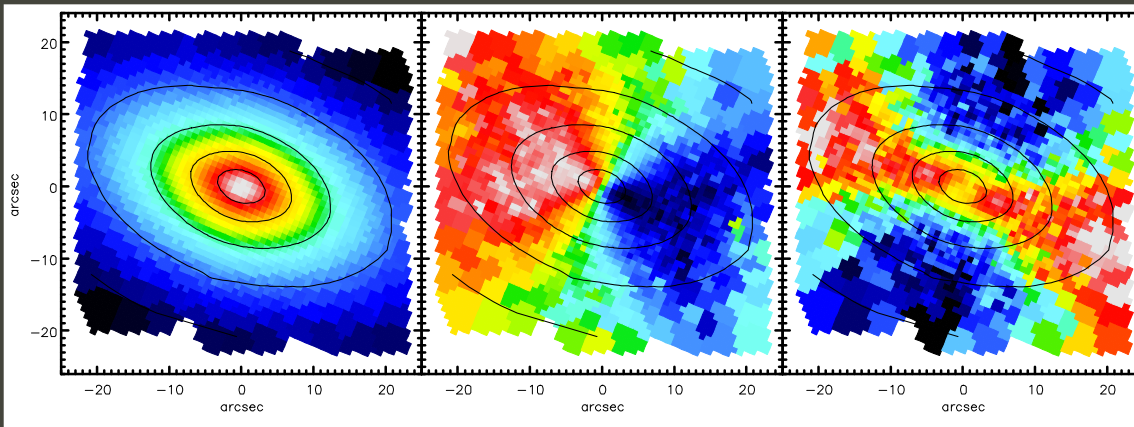


Rix et al. 1992



GALAXIES ARE COMPLEX

- Multiple large-scale disk components



NGC 4550

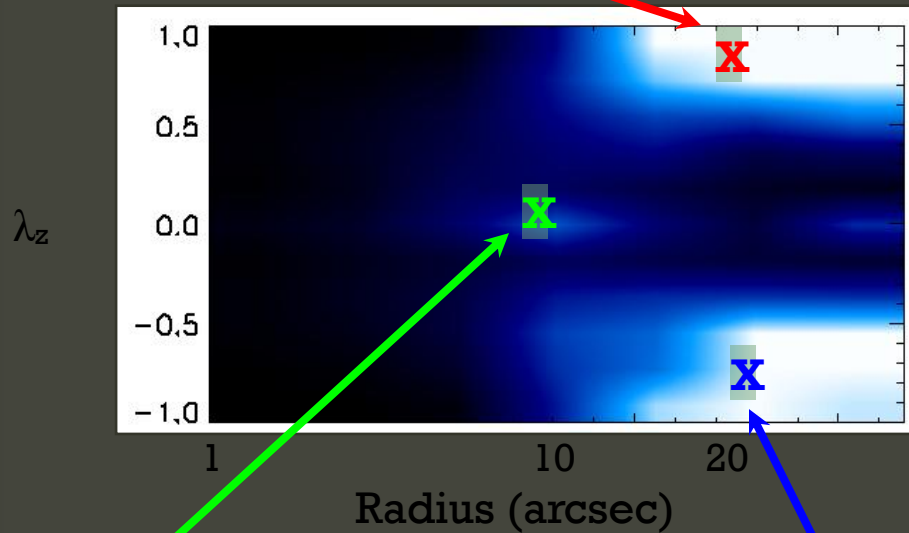
Atlas3D
Cappellari et al. 2011

DISK-DOMINATED ETC

*NGC4550 known to host two counter-rotating disks
with different scale-heights (Rix et al. 1995)*



prograde disk-like orbits

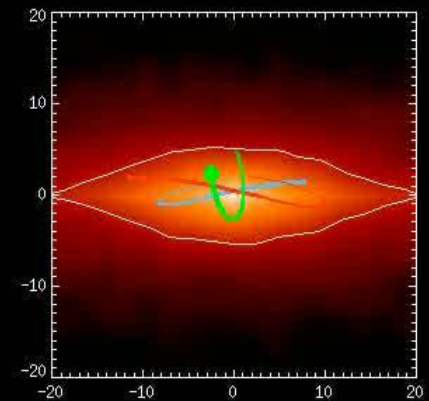


bulge-like orbits

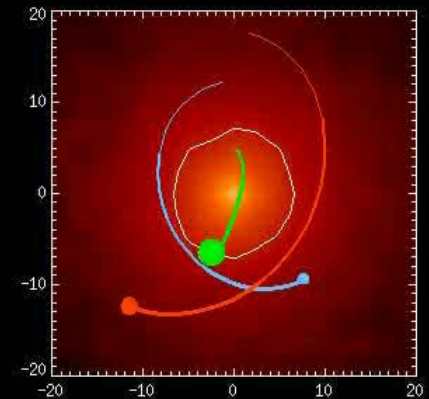
retrograde disk-like orbits

λ_z = normalized angular momentum around short z-axis

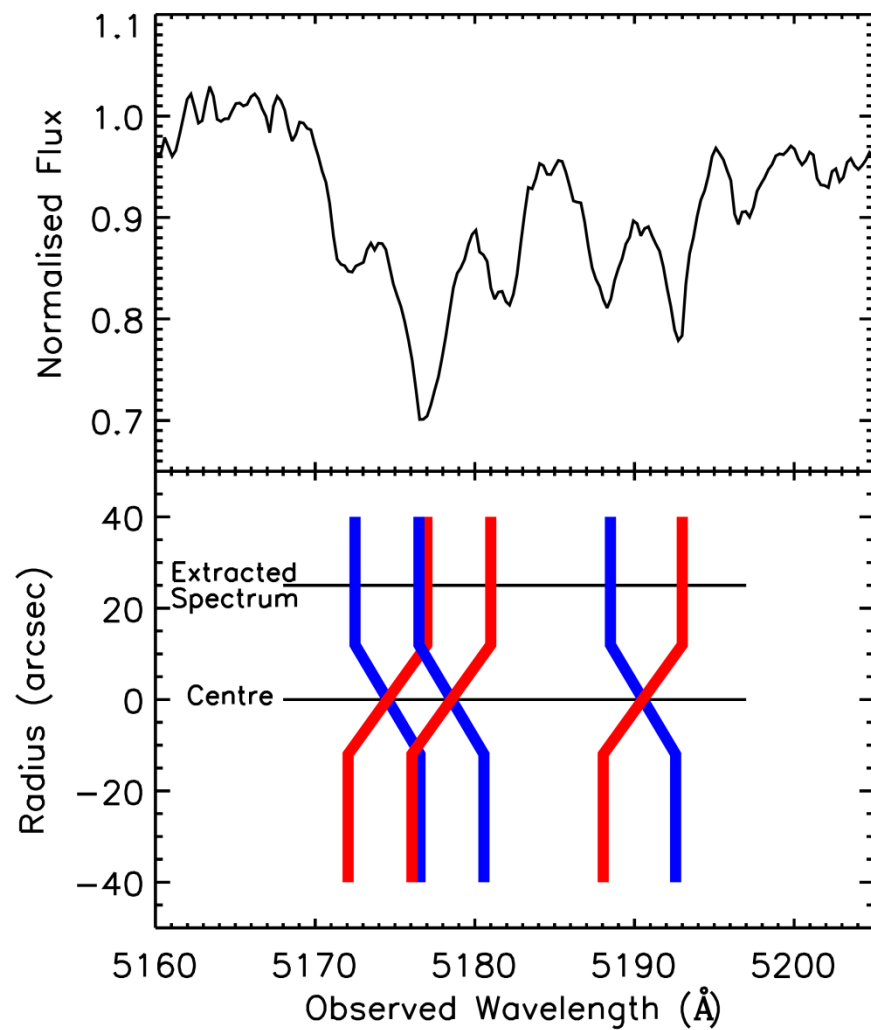
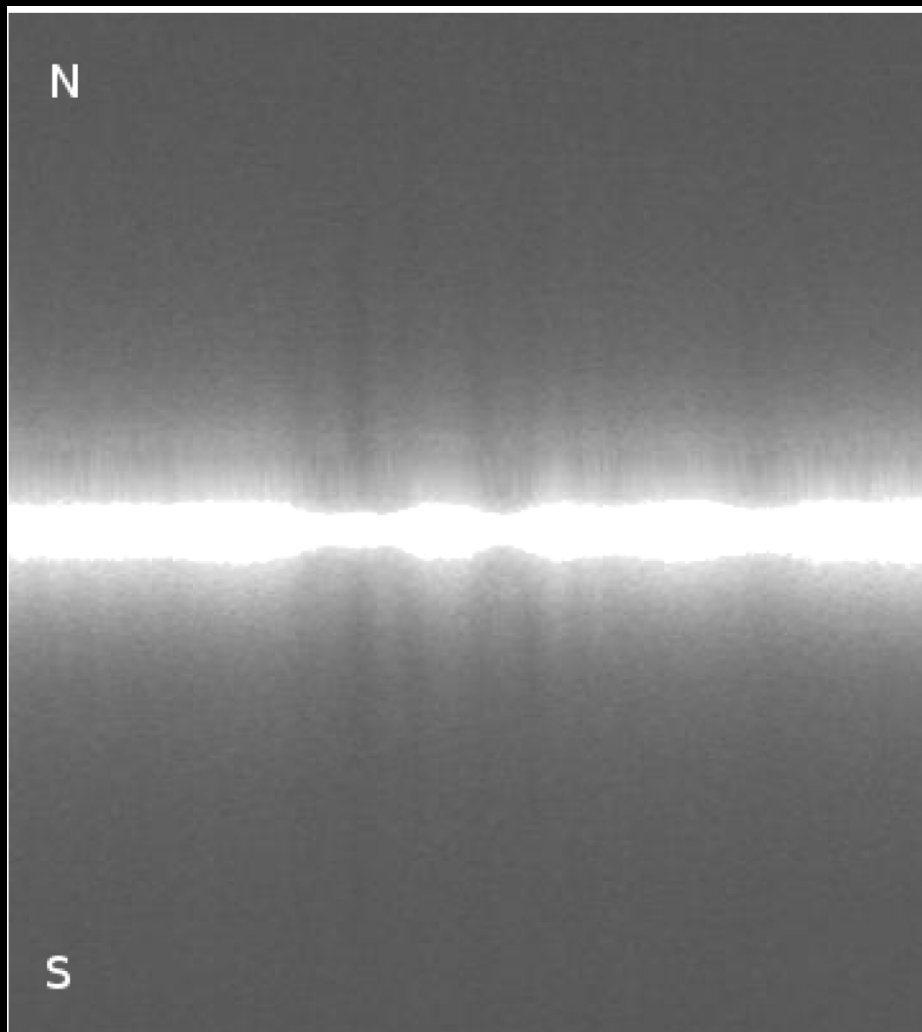
Edge-on view

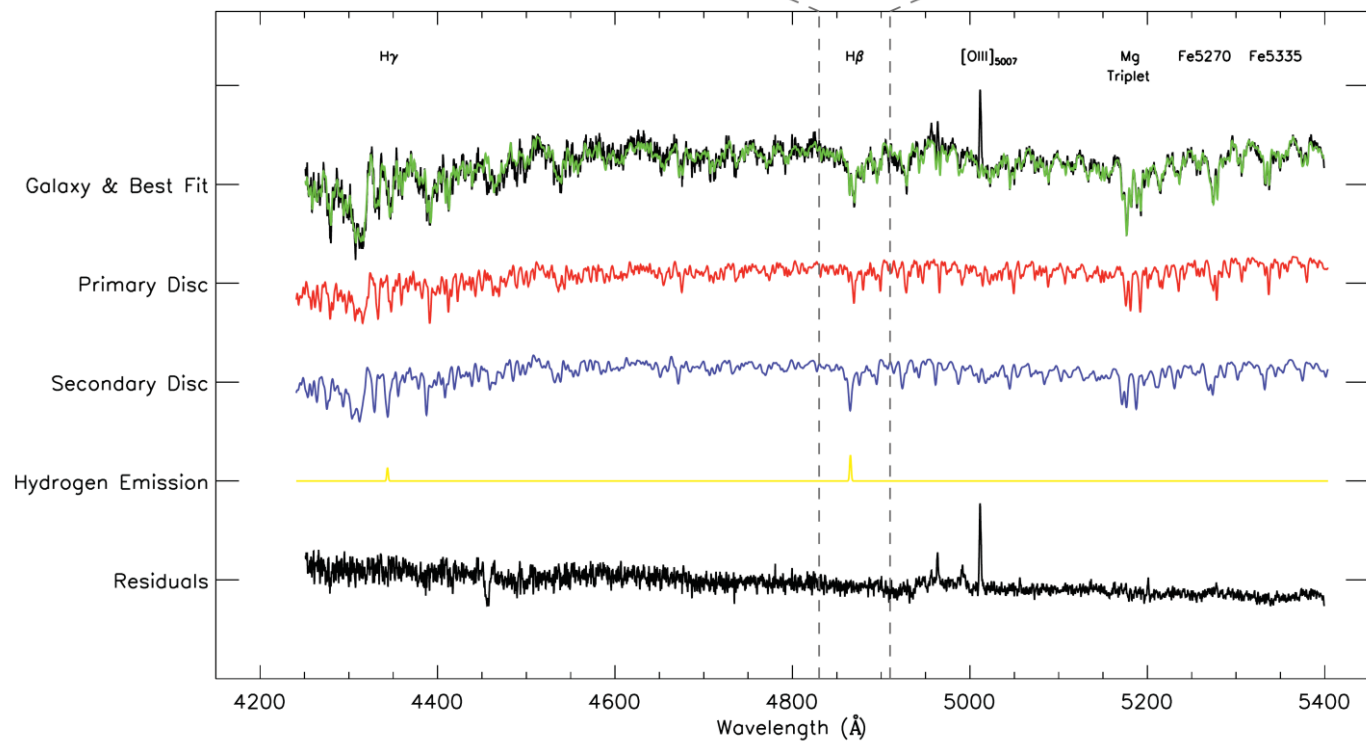
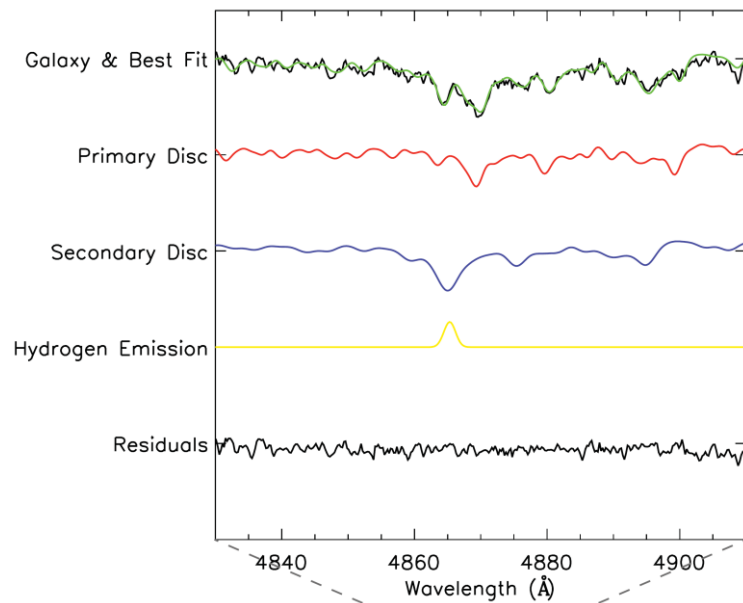


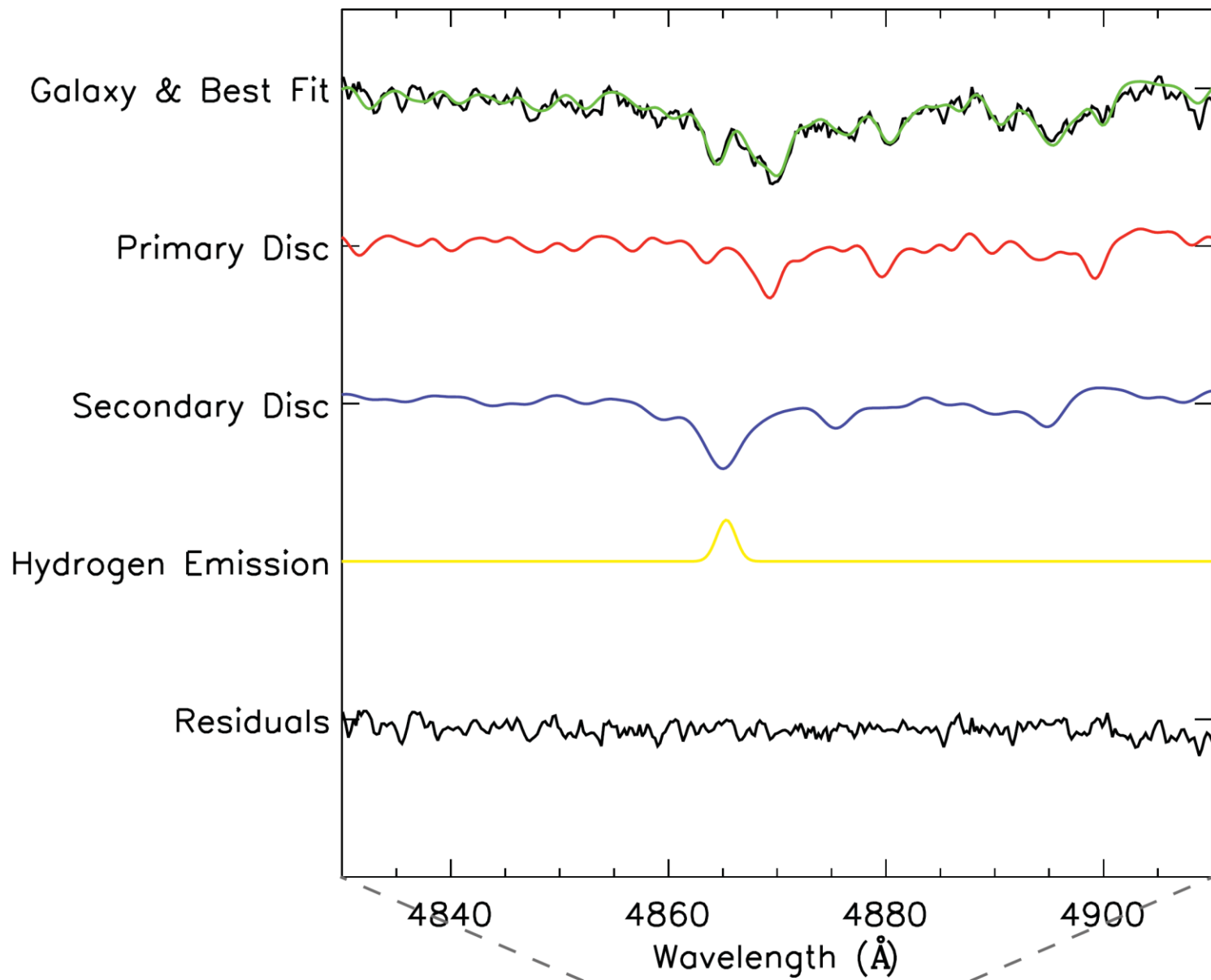
Face-on view

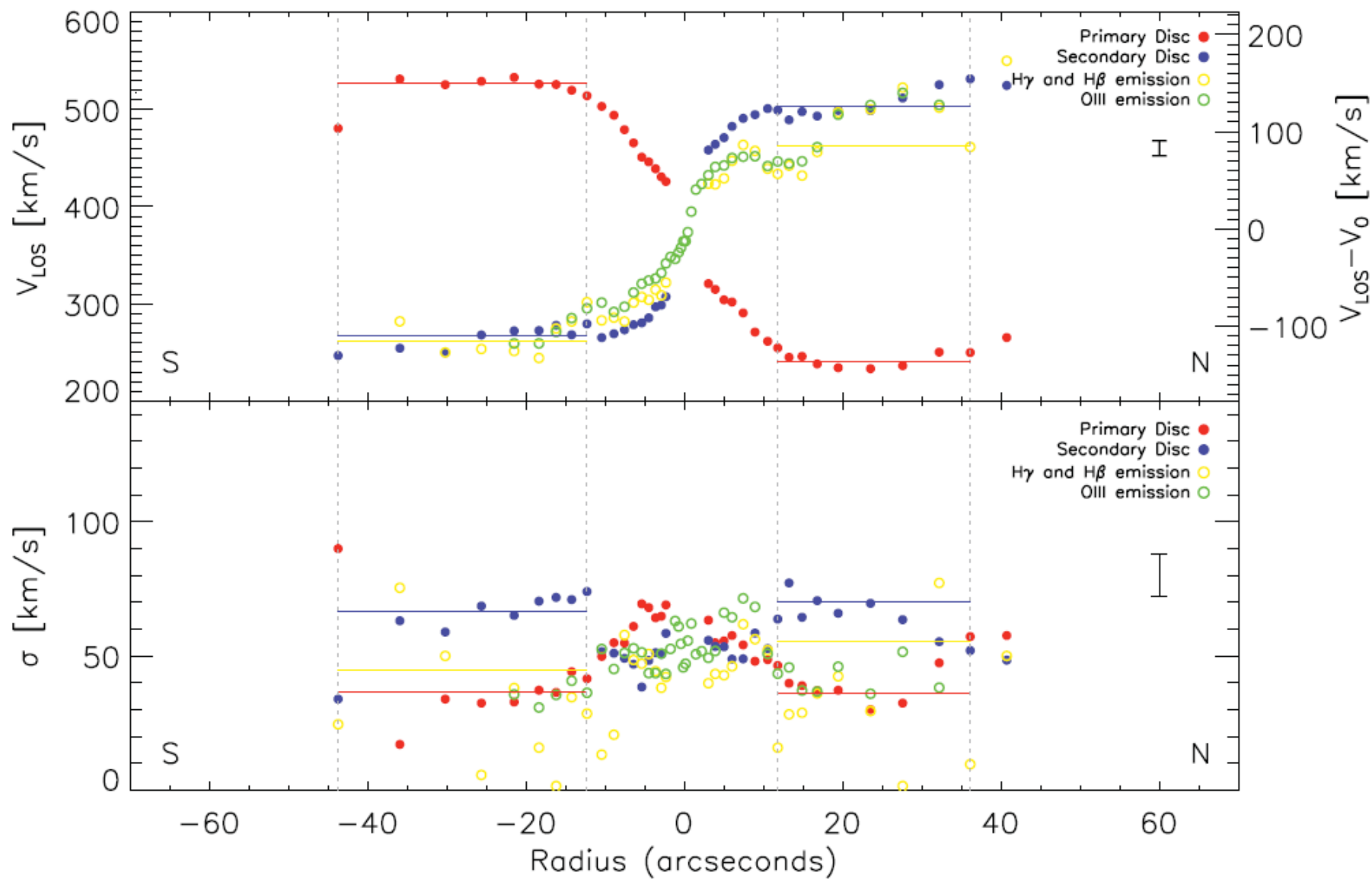


movie by G. van de Ven









How do we form such a system?

1. Merger of two counter-rotating stellar disks of similar mass

→ Initial conditions need to be “just right”:
coplanar disks with carefully-chosen parabolic orbit.
Only possible if extremely rare object.

Puerari & Pfnniger (2001)

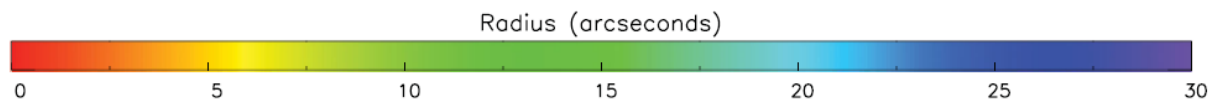
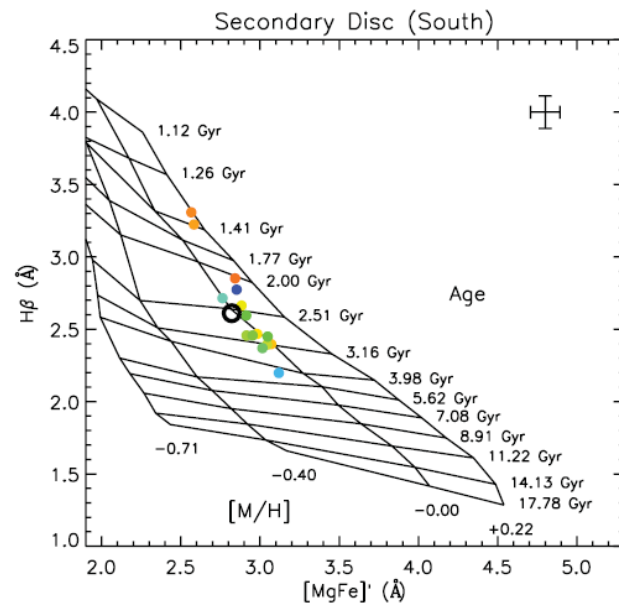
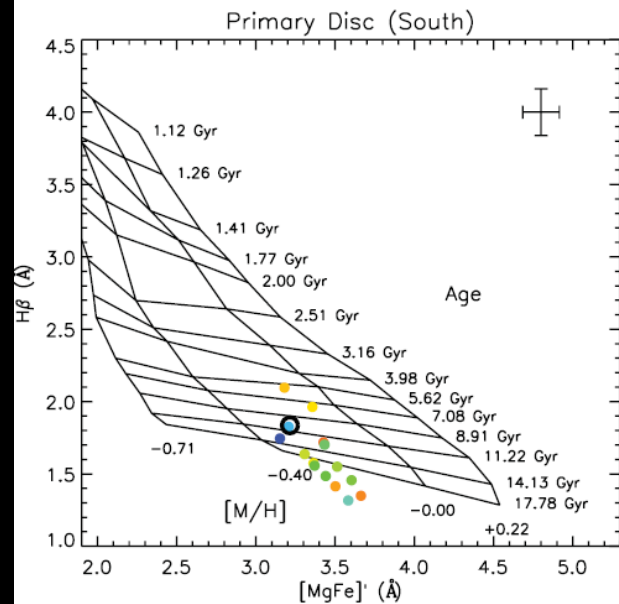
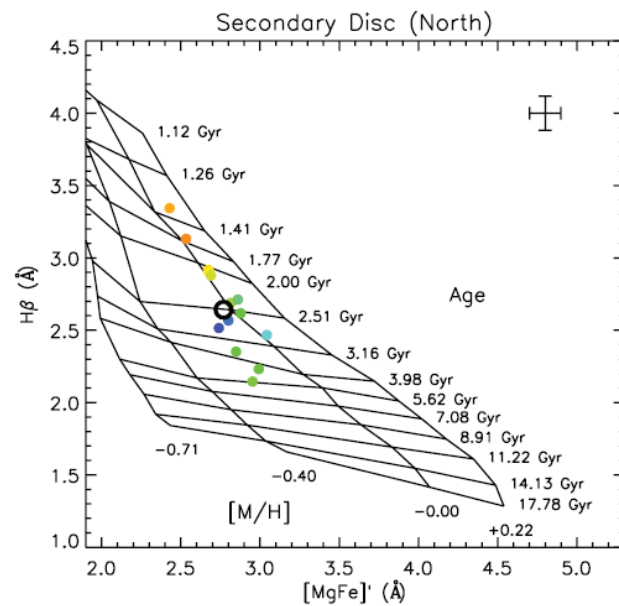
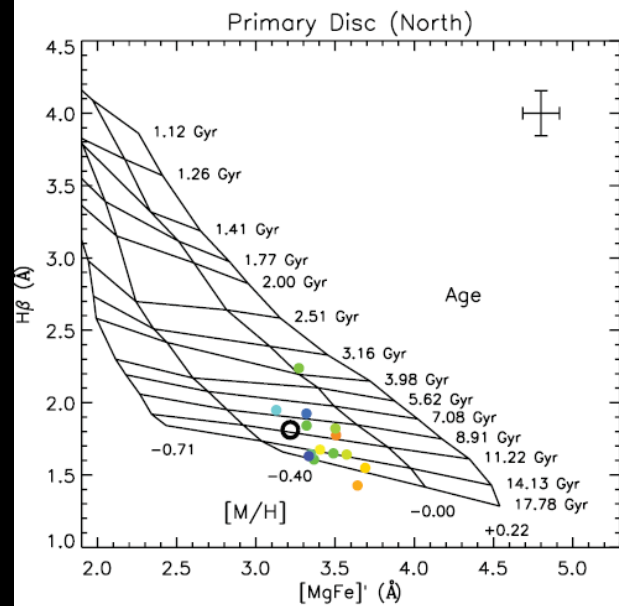
Crocker et al (2009)

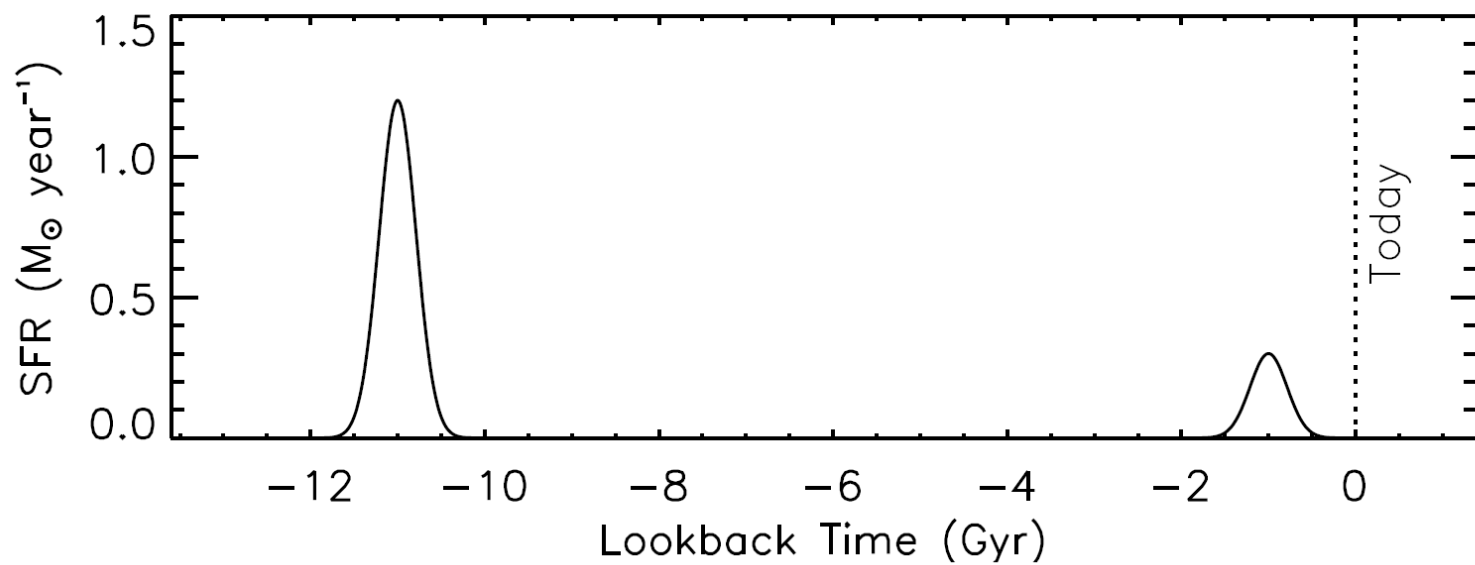
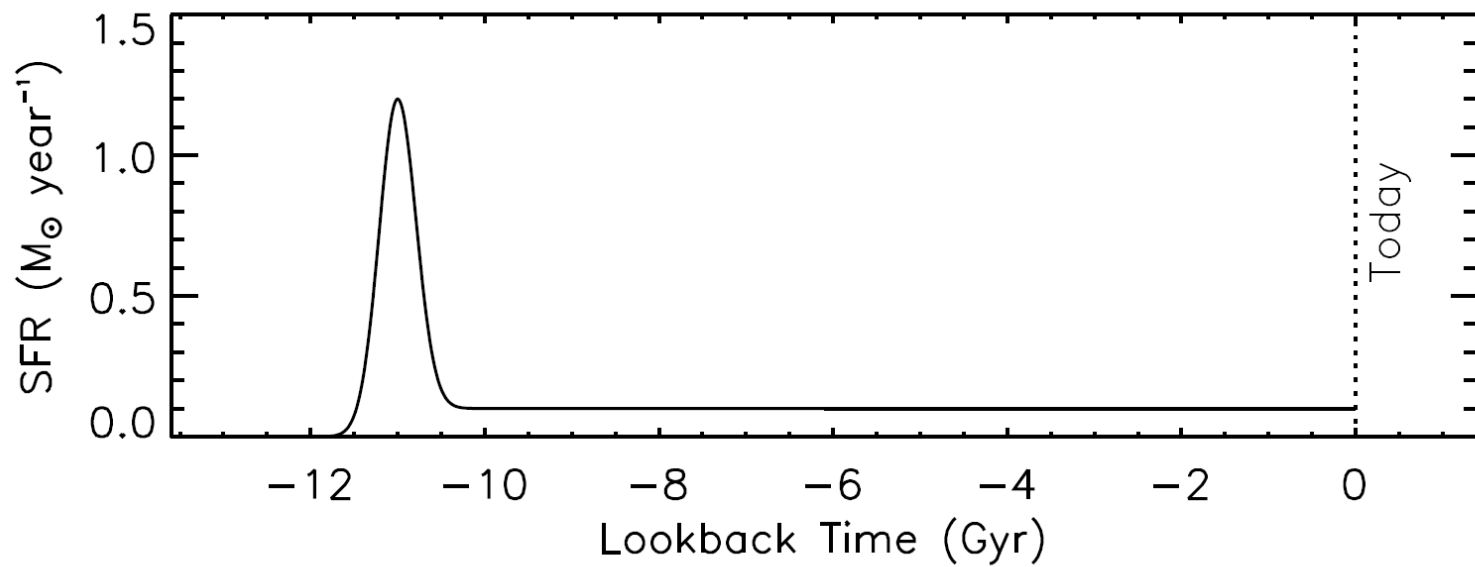
2. Slow gas accretion or series of mergers with gas-rich dwarf galaxies.

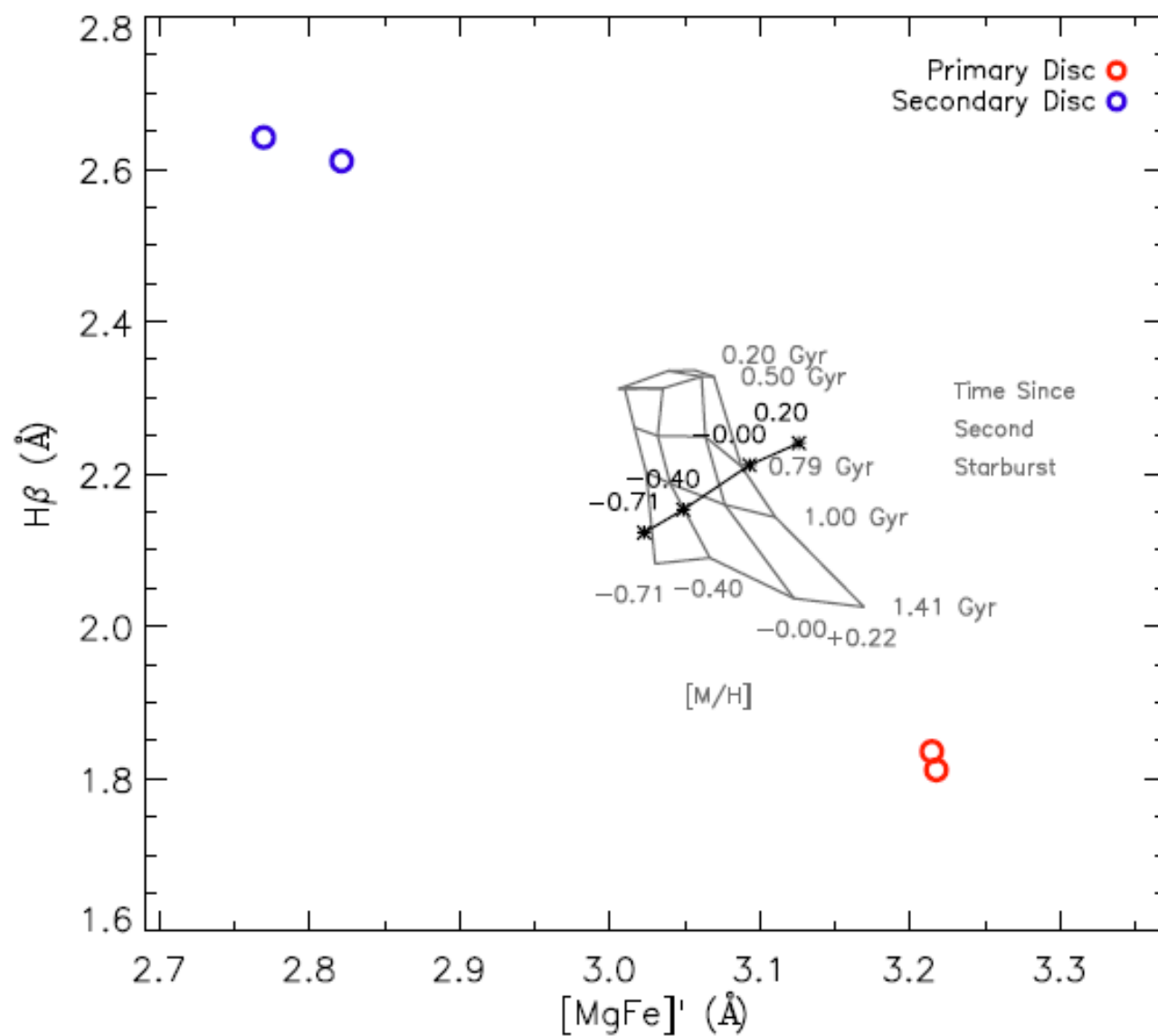
Thakar & Ryden (1996,1998)

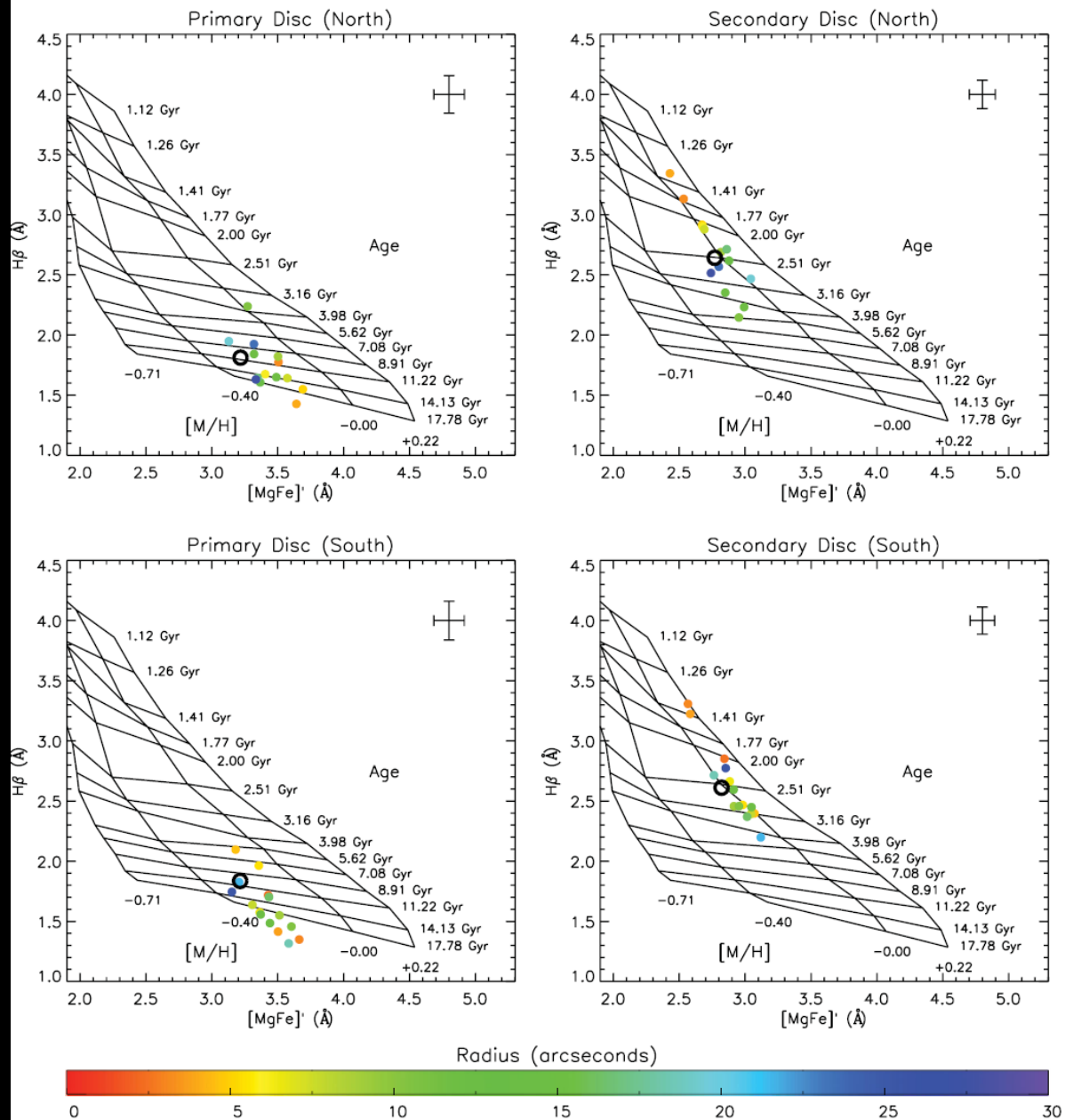
3. Separatrix-crossing.

Evans & Cpllett (1994)









Summary

- NGC 4550 has two counter-rotating stellar disks plus a gaseous component.
- Both disks have similar masses and sizes, but distinct stellar populations.
- The secondary disk is younger and thicker, with a clear age gradient (younger at the centre).
- The gaseous component almost co-rotates with the secondary disk, but not quite (peculiar kinematics!)
- Evans & Collett's (1994) elegant 'separatrix-crossing' model ruled out (pity!!!)
- Formation requires some form of unusual gas accretion history.

→ This galaxy had an interesting youth,
like many of us (don't ask!!!)