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Astrophysik  
Universität Wien

# Das Reich der Galaxien



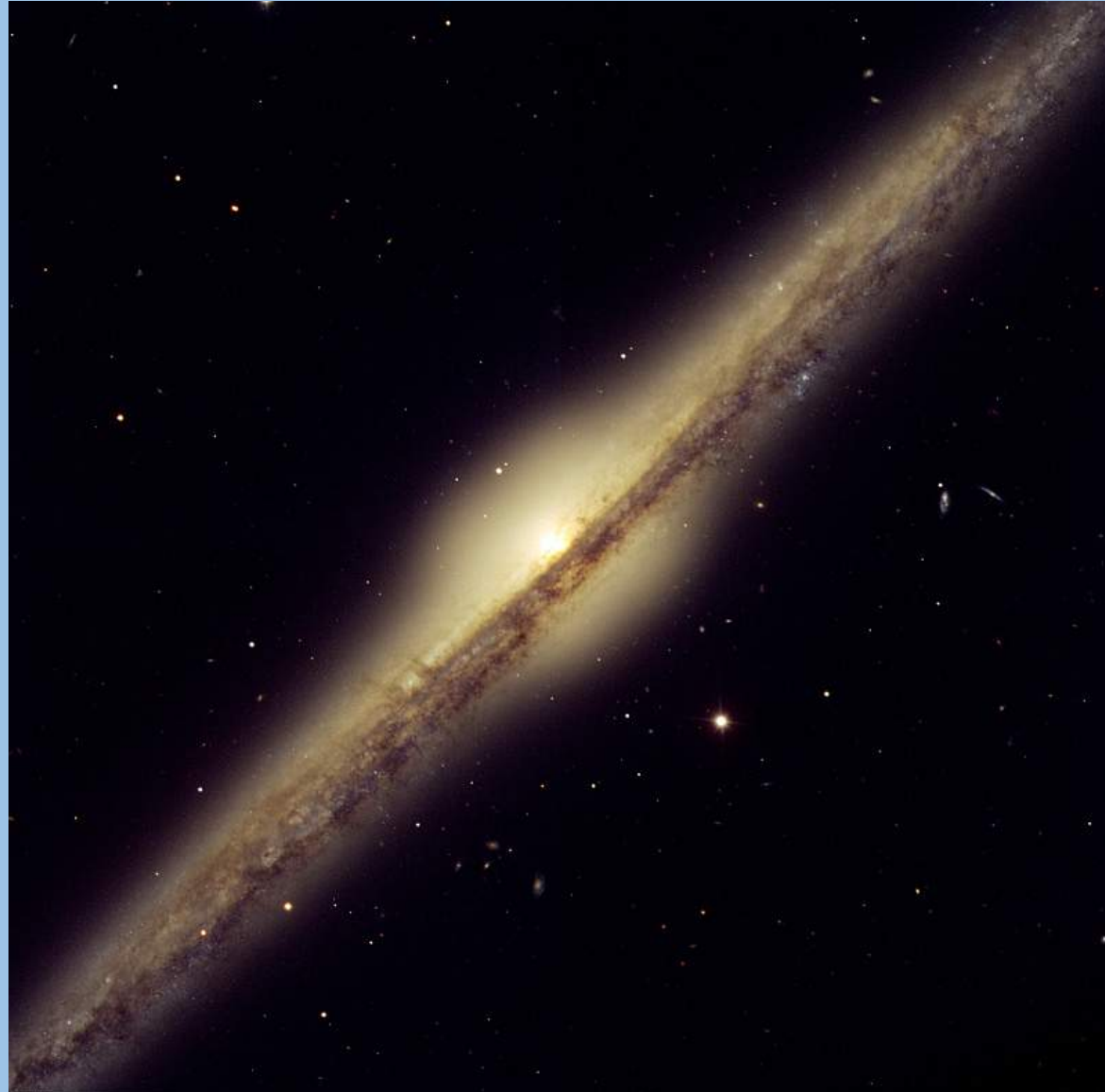
## Spiralgalaxien



NGC  
1231

FORS am  
Very Large  
Telesope  
Europäische  
Südsternwarte

## Spiralgalaxien



NGC  
4565

FORS am  
Very Large  
Telesope  
Europäische  
Südsternwarte

## Balkenspiralgalaxien



NGC  
1097

VIMOS am  
Very Large  
Telesope  
Europäische  
Südsternwarte

## Elliptische Galaxien



M 87

Anglo-  
Australisches  
Observatorium

## Linsenförmige Galaxien



Sombrero

FORS am VLT  
ESO

## Irreguläre Galaxien



Kleine  
Magellansche  
Wolke



## Wechselwirkende Galaxien

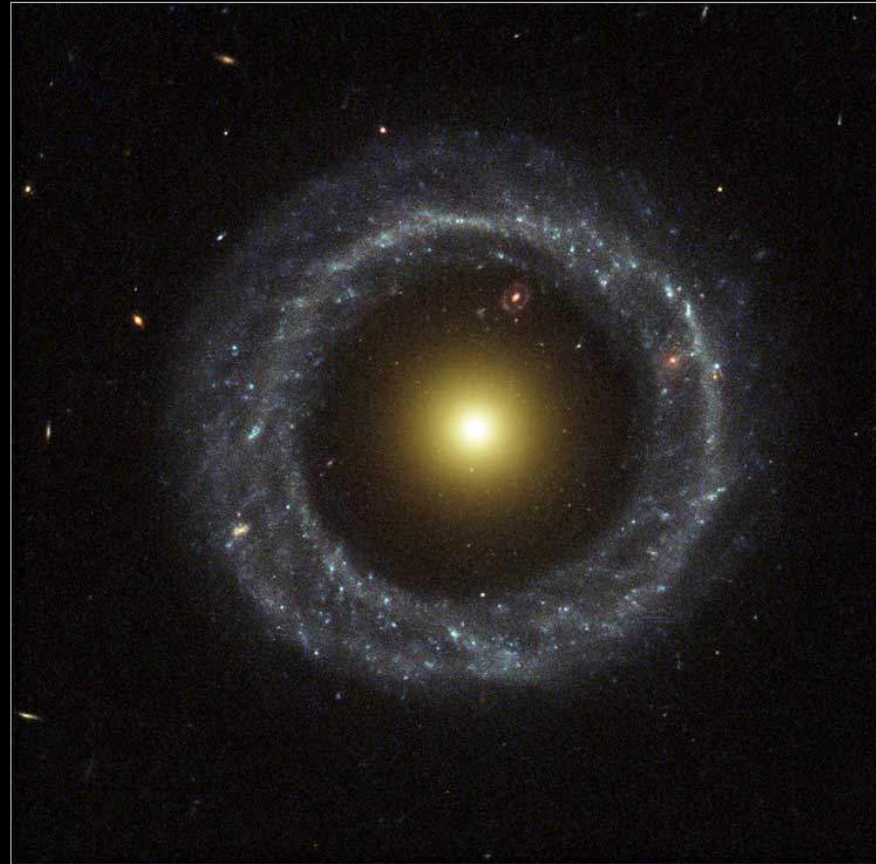


HST/ACS

Die  
spielenden  
Mäuse

## Pekuliare Galaxien

Hoag's Object

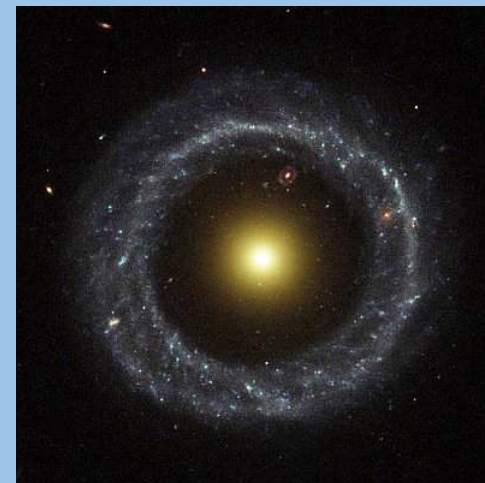
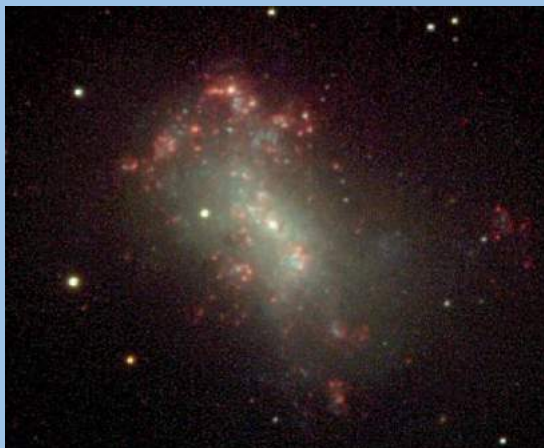


Hoag  
Ringgalaxie

HST/NASA

Hubble  
Heritage

# Das Reich der Galaxien

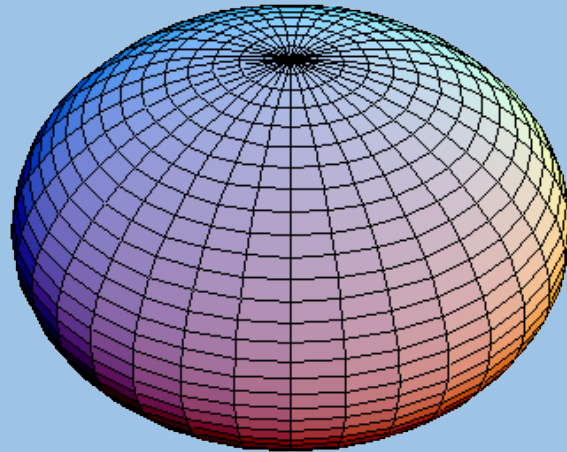
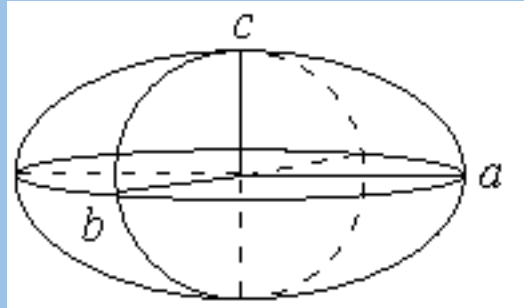


## Physik der Galaxien

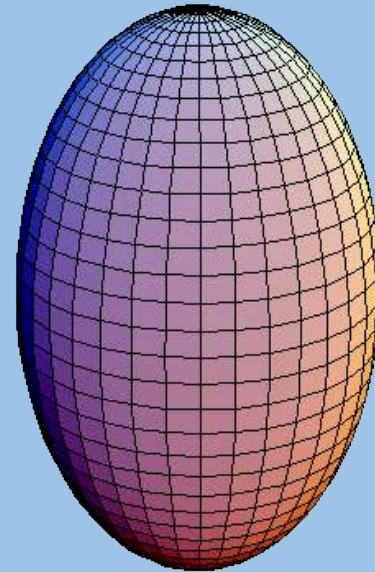
- Welche Masse besitzen Galaxien? (“wie schwer sind sie”?)
- Welche Komponenten/Strukturen gibt es?
- Wie bewegen sich die Sterne / das Gas? (Kinematik)
- Wie alt sind Galaxien? (Entstehen sie? Entwickeln sie sich?)
- Welche Sternpopulationen gibt es?
- Wieviel Sterne bilden sich neu in den verschiedenen Epochen?
- Was ist die Rolle der Schwarzen Löcher?
- etc usw

3D Spektroskopie

# Three-dimensional shape

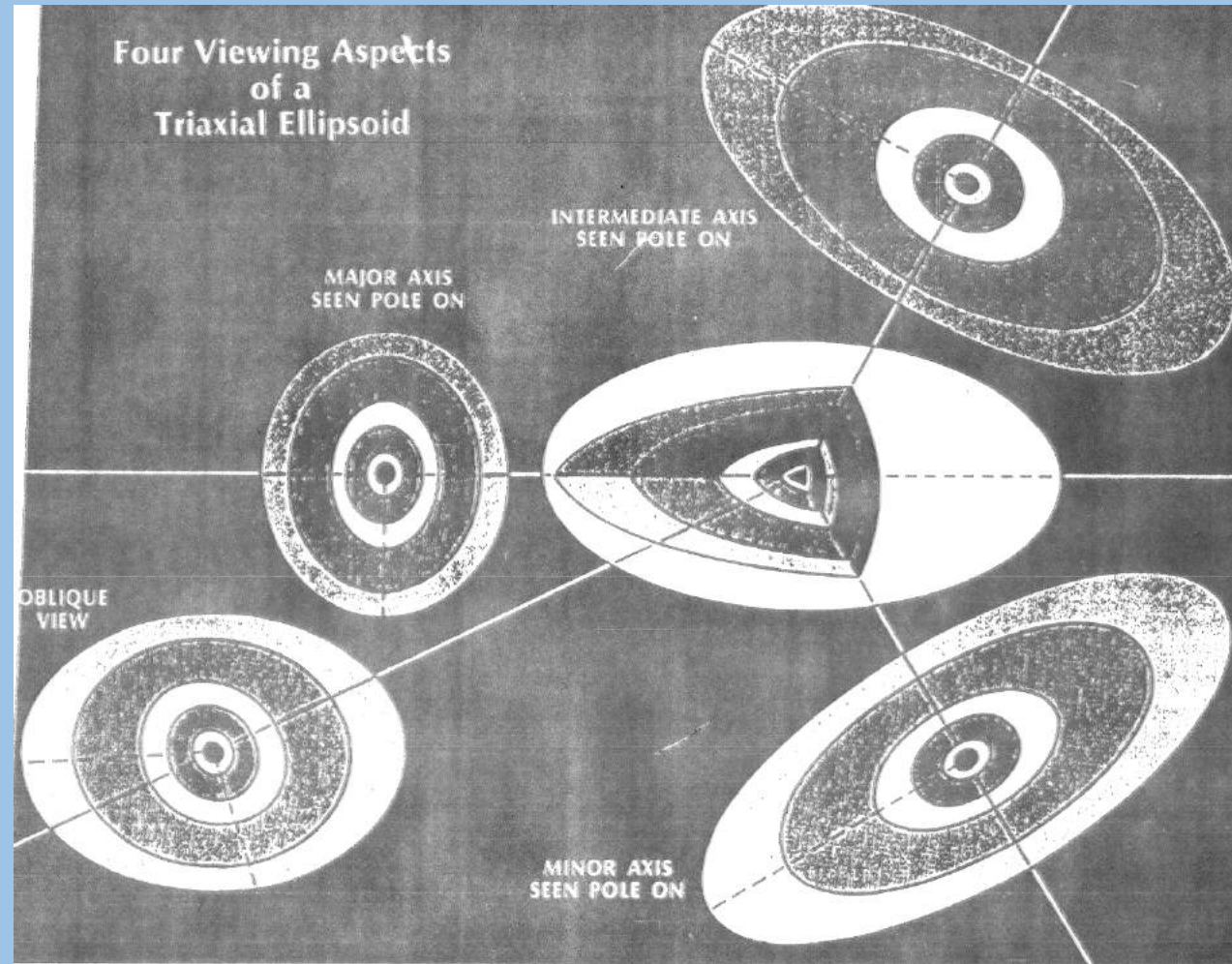


oblate



prolate

## 2D: Projektion auf 2 Ebenen



Form hängt von Blickwinkel (Sichtlinie) ab

also exhibit the twisting phenomenon of their major axes at varying distances from the center.

# Stellare Orbits: Sternbahnen

box orbit



short-axis  
tube orbit



inner  
long-axis  
tube orbit

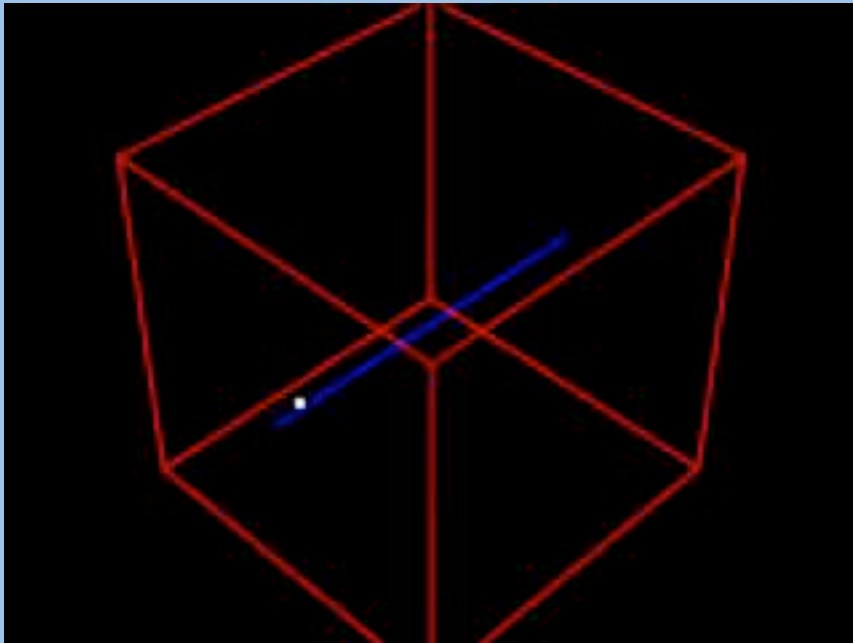


outer  
long-axis  
tube orbit

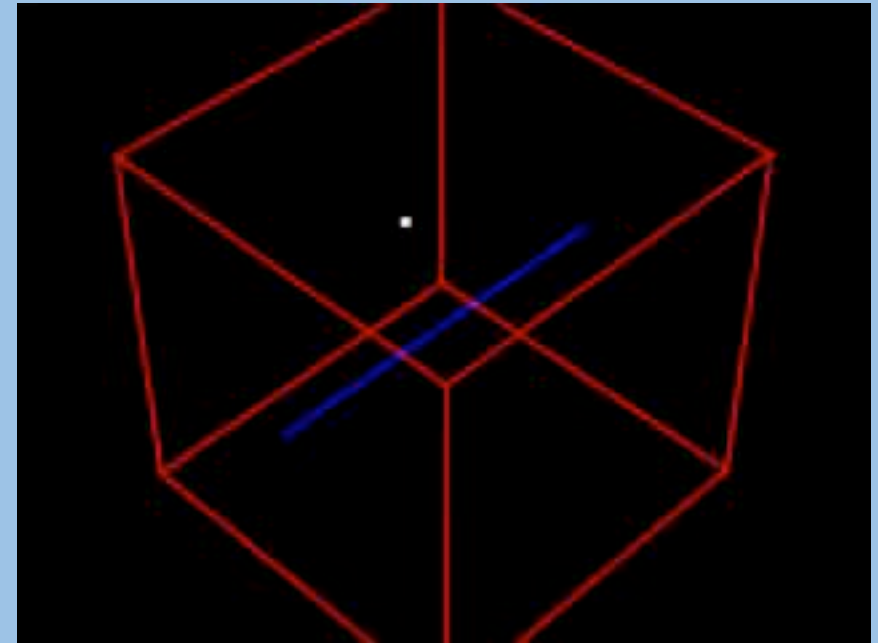


# Stellare Orbits: Sternbahnen

box orbit

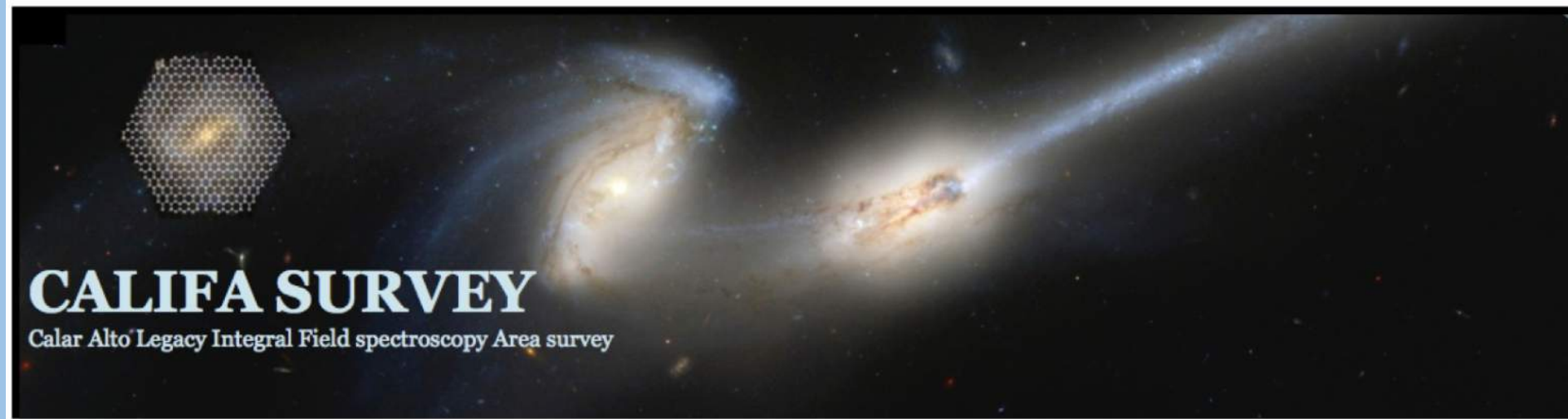


pretzel orbit

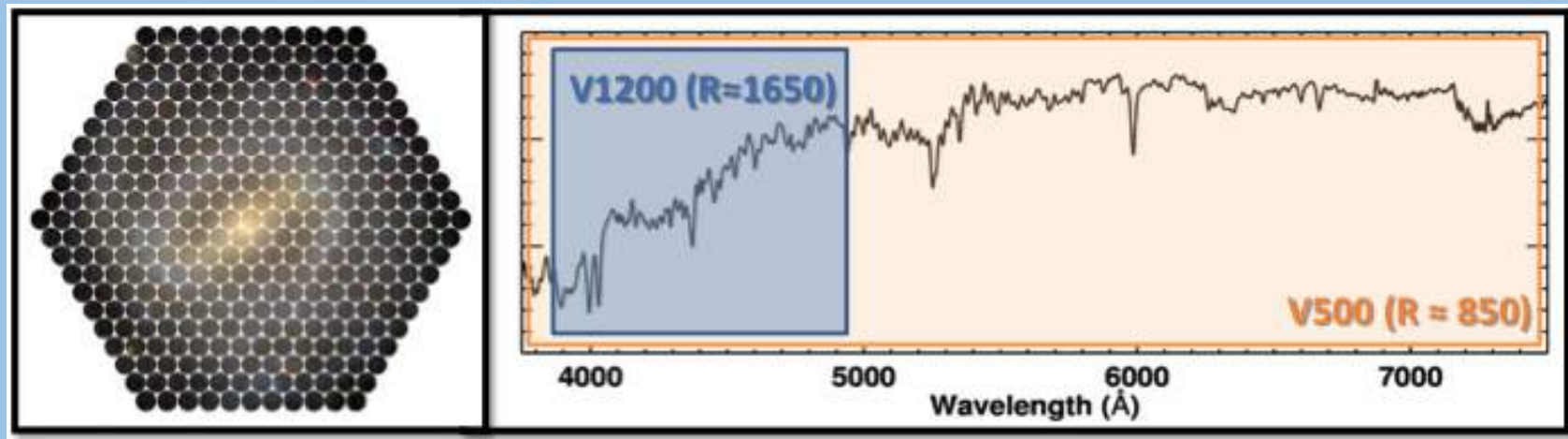




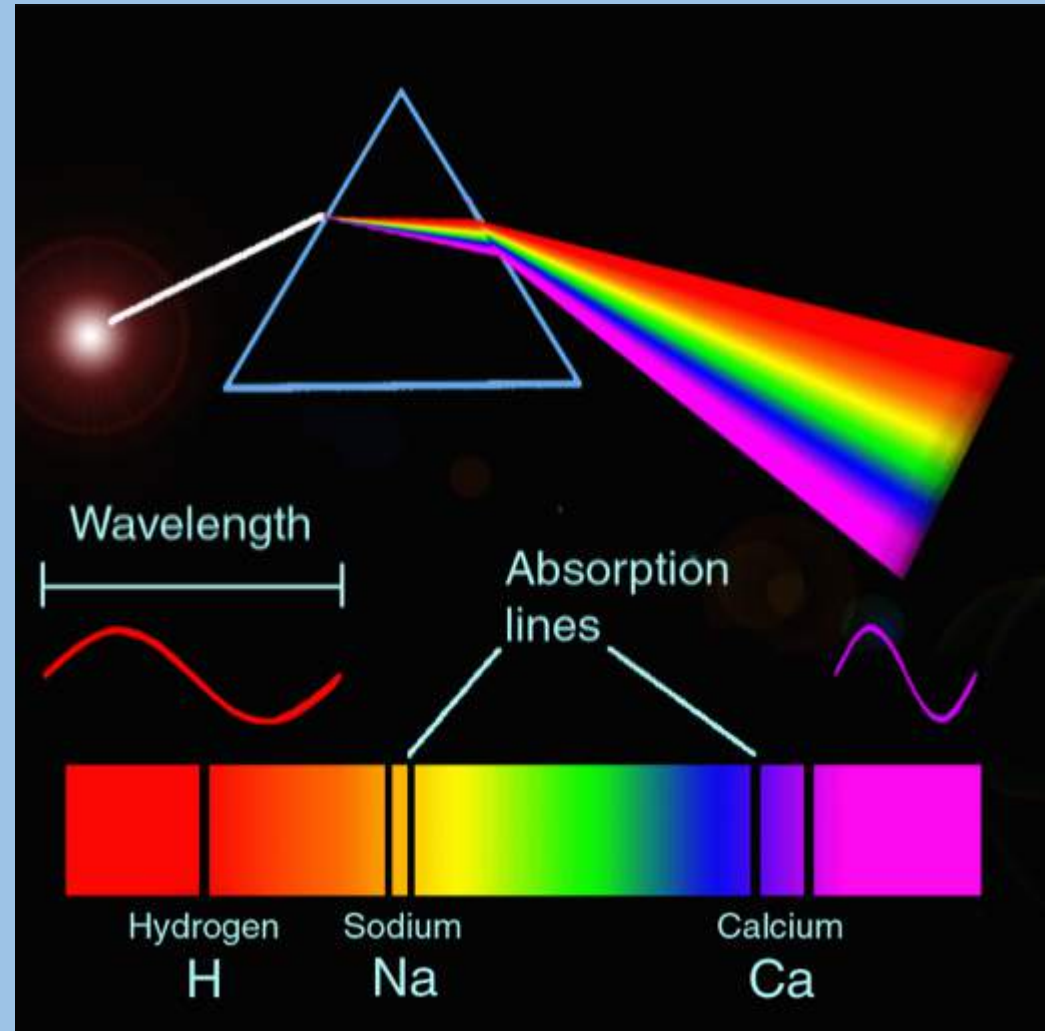
# Physik der Galaxien: CALIFA



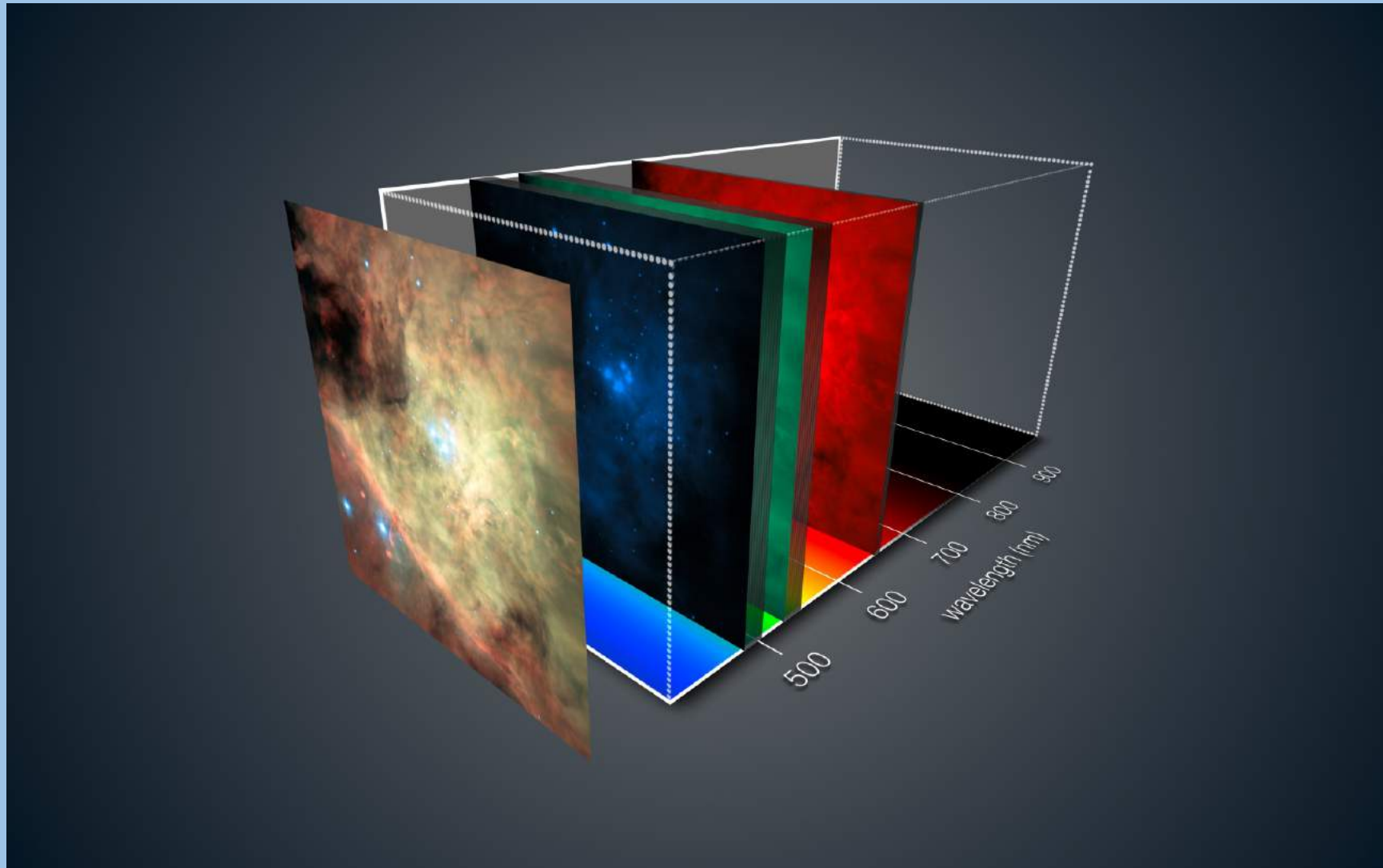
## Spektroskopie



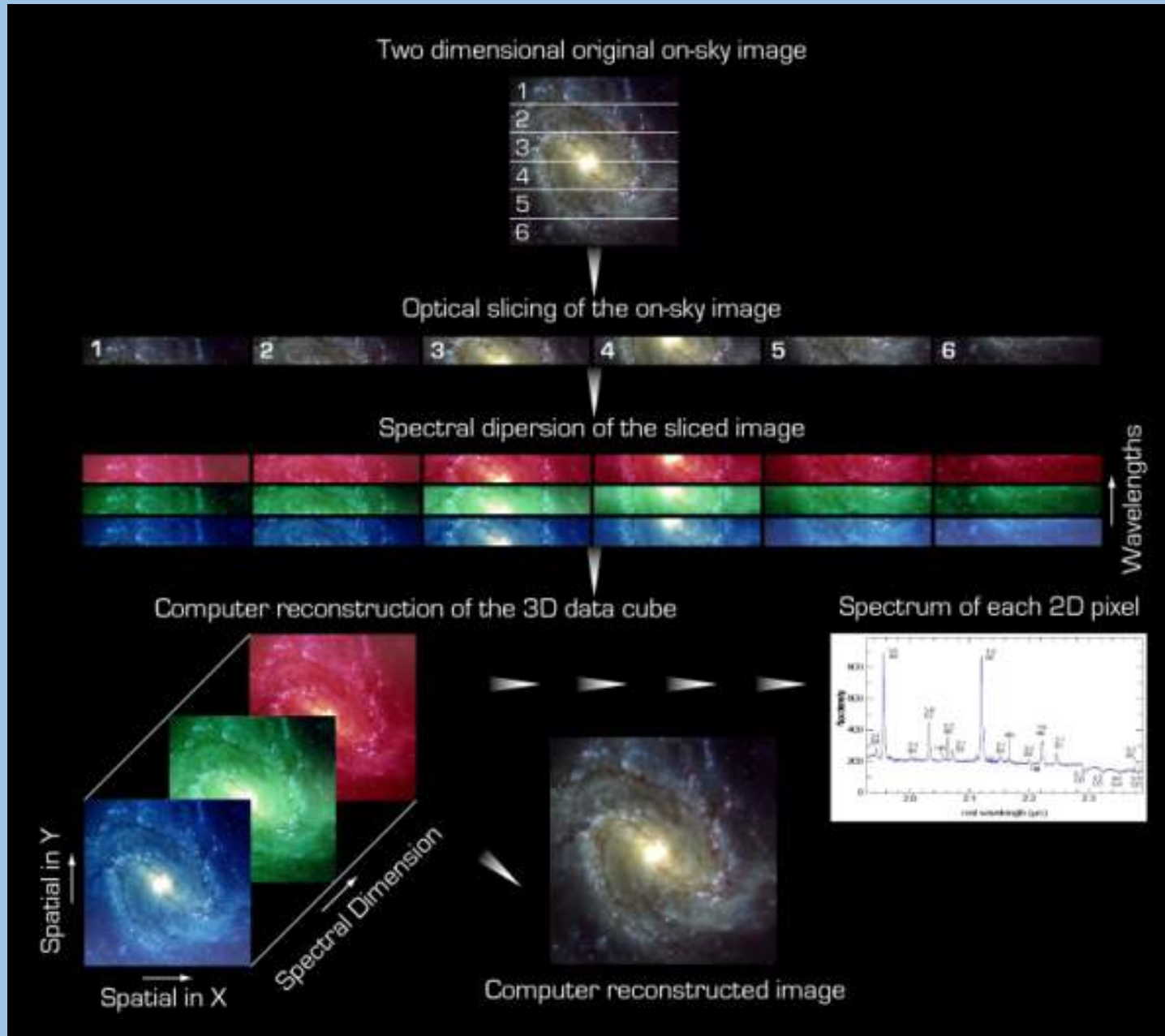
# Spektroskopie



# 3D Spektroskopie



# 3D Spektroskopie



Gas: Emission

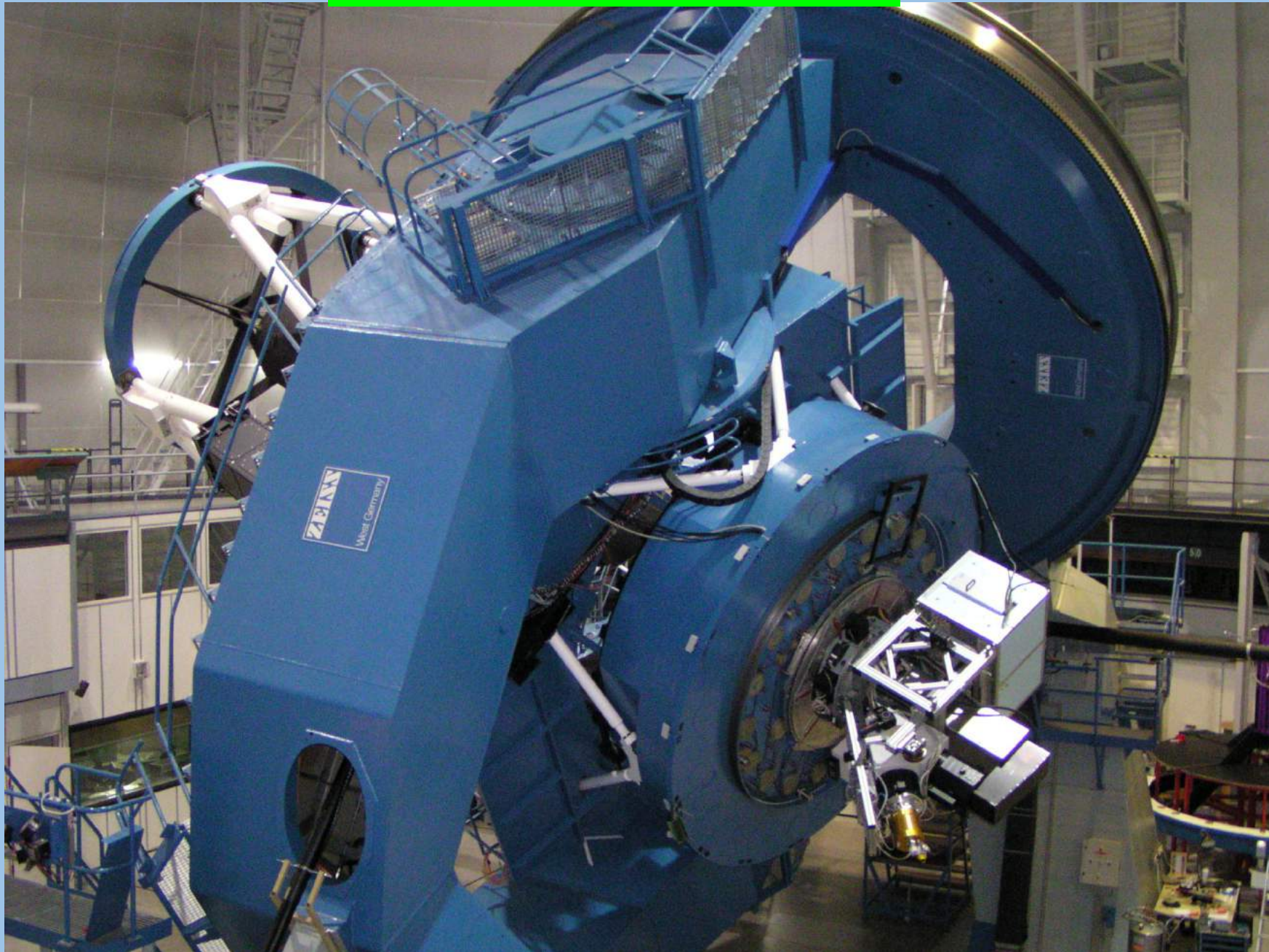
Sterne: Absorption

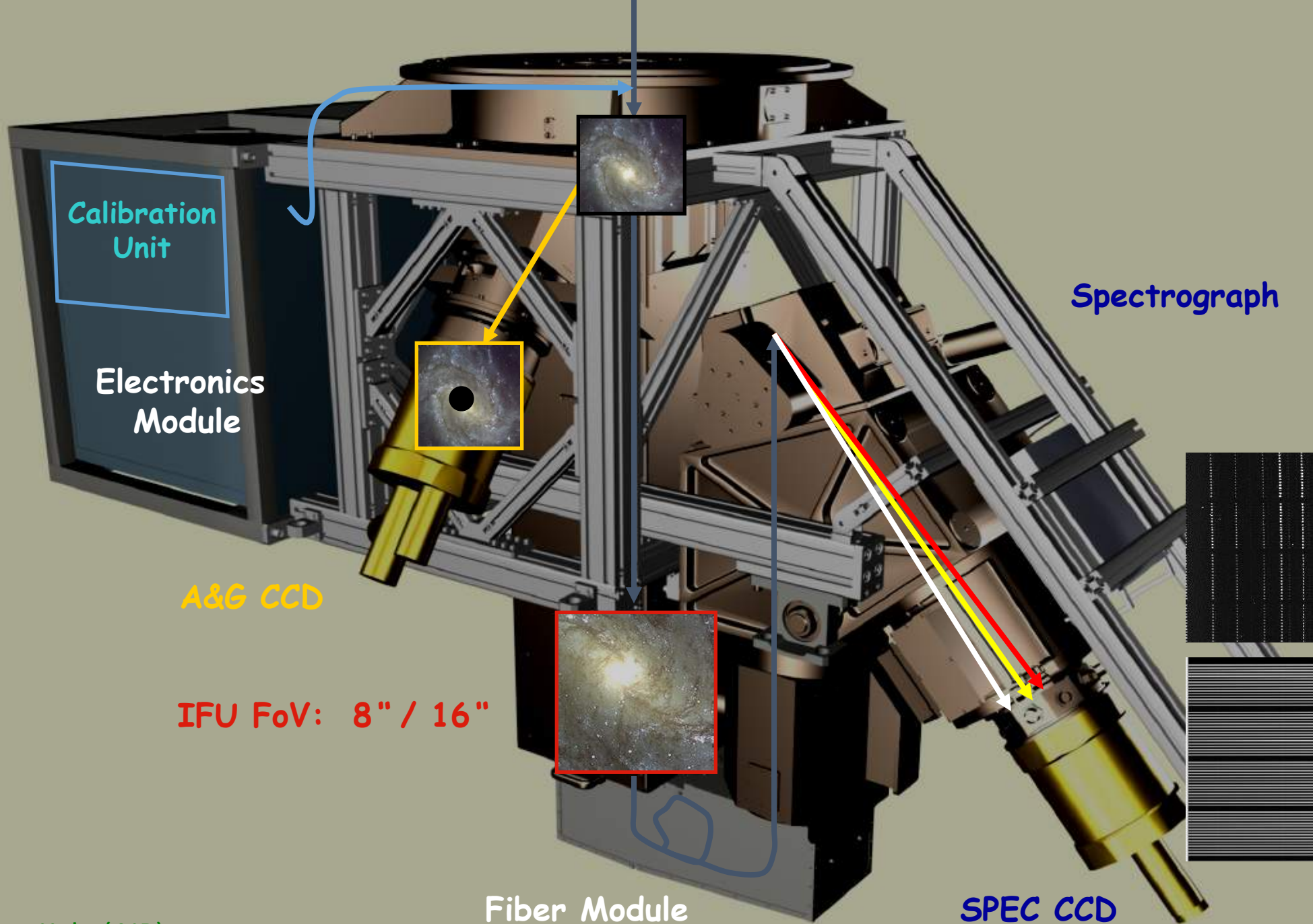
Wegner (USM)



## Calar Alto Observatorium (CAHA)







Calibration Unit

Electronics Module

Spectrograph

A&G CCD

IFU FoV: 8" / 16"

Fiber Module

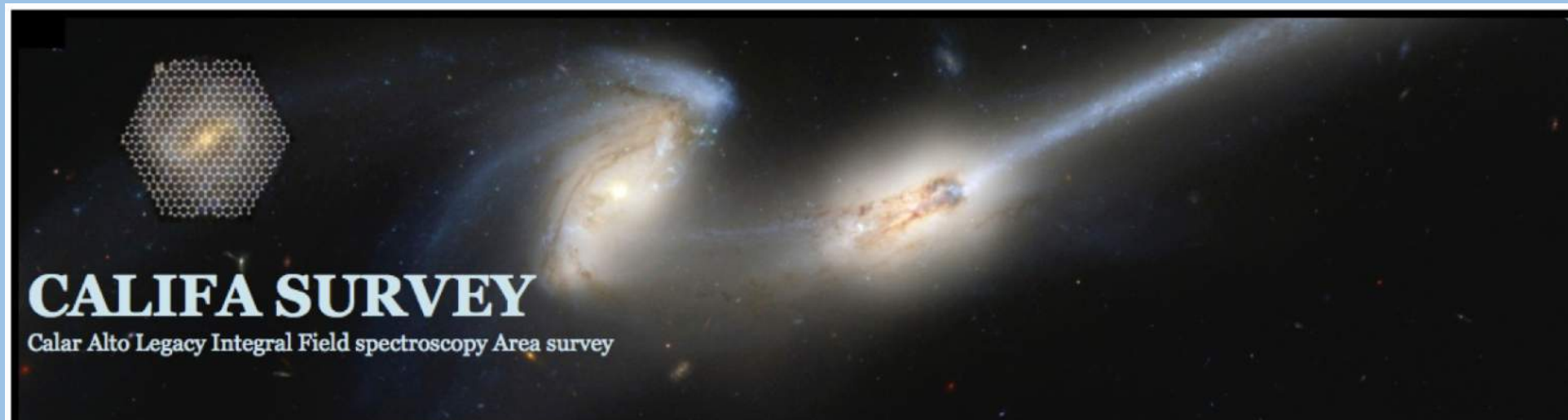
SPEC CCD

Keltz(AIP)

## CALIFA 3D Survey

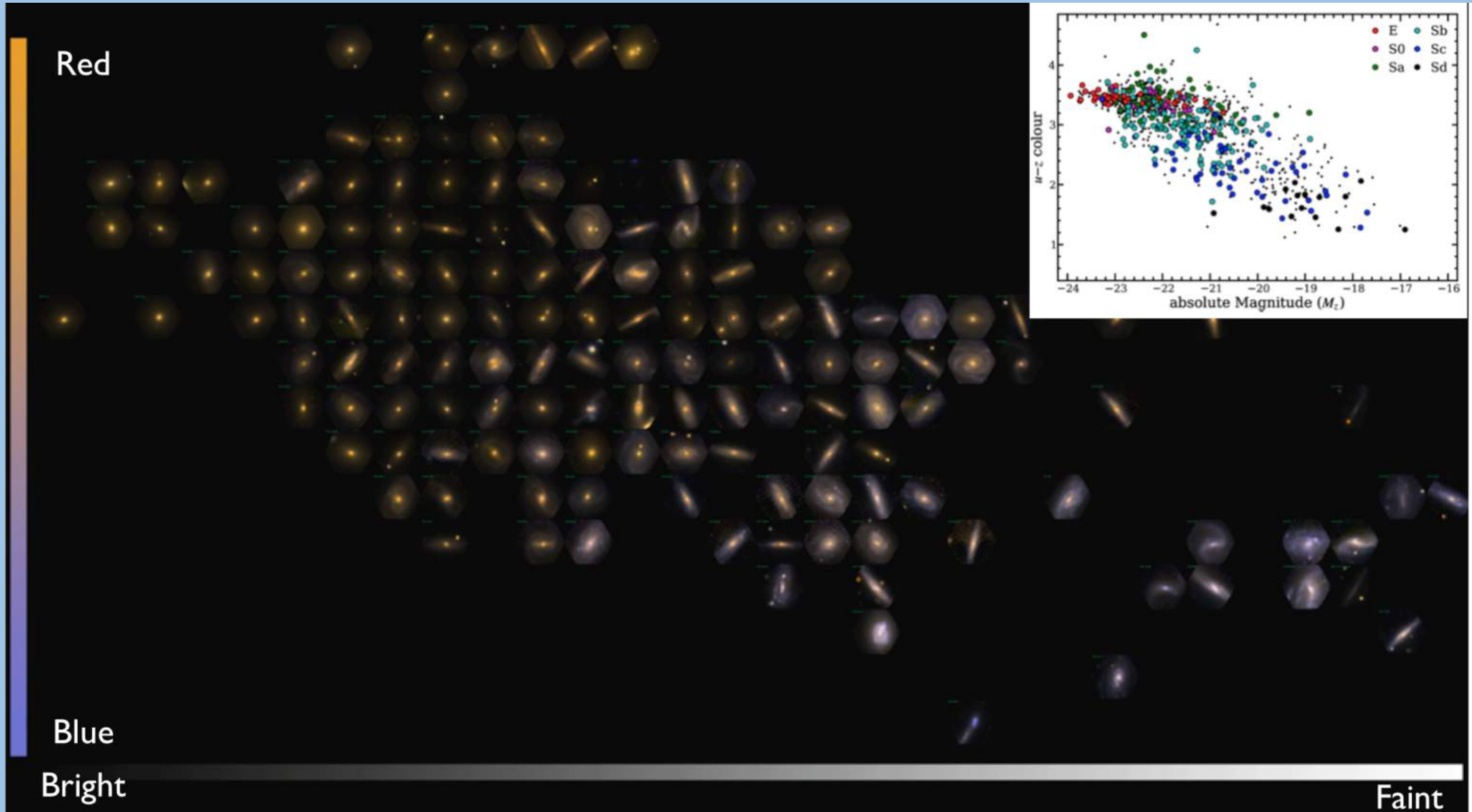
[www.caha.es/CALIFA](http://www.caha.es/CALIFA)

- 3D Spektroskopie mit PPAK/PMAS am 3.5m-T. CAHA
- 300 (dunkle) Nächte über 3,5 Jahre hinweg
- 80 Wissenschaftler von 20 Instituten in 7 Ländern
- PI: S. Sanchez (UNAM), PS: C.J. Walcher (AIP)
- 667 Galaxien im lokalen Universum ( $0.005 < z < 0.03$ )
- Alle Hubble Galaxientypen





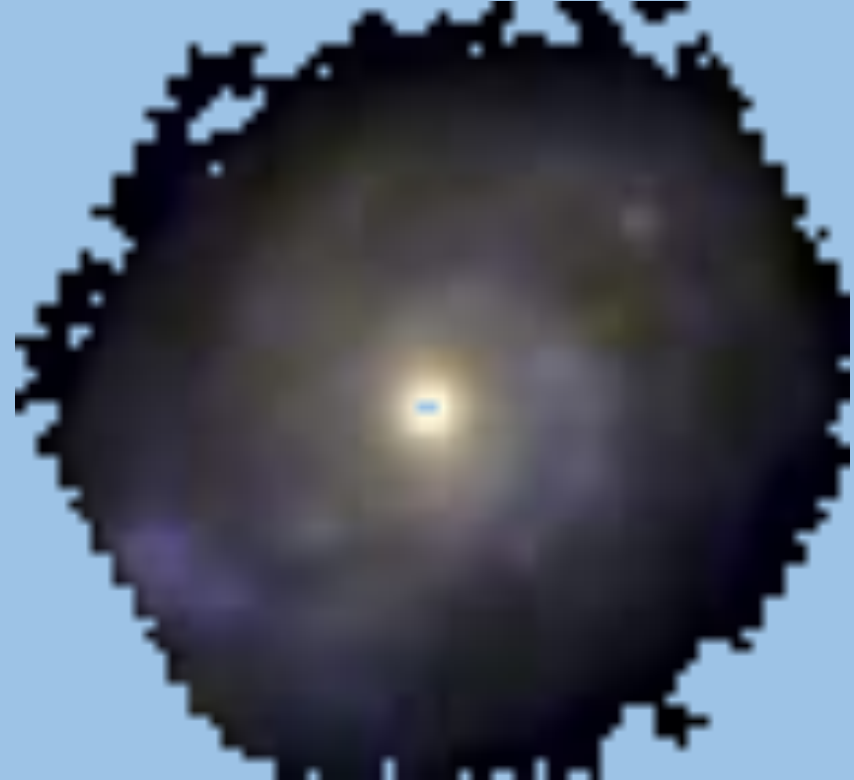
# CALIFA: Farben-Helligkeits-Diagramm



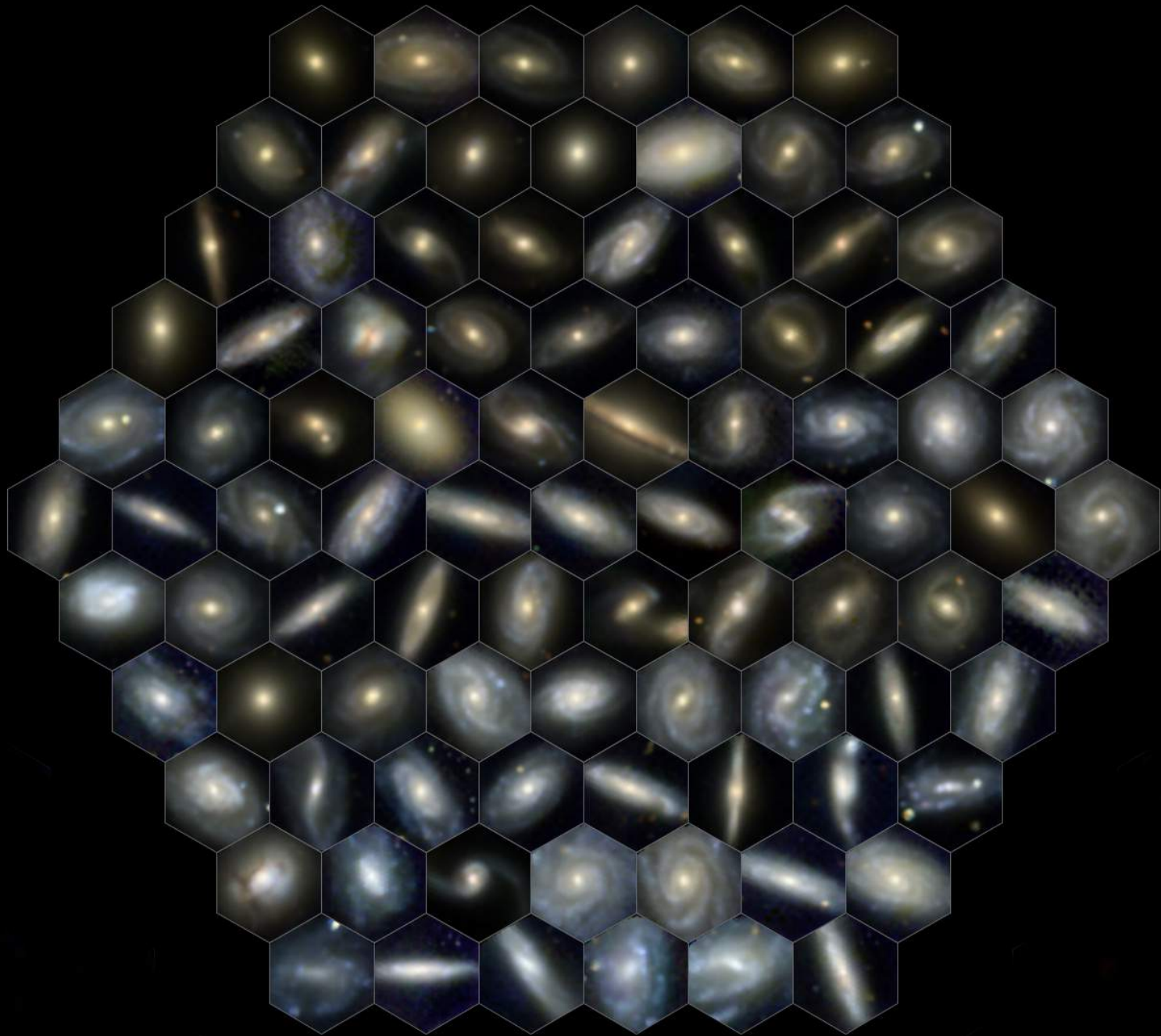
## Spiralgalaxie NGC2253



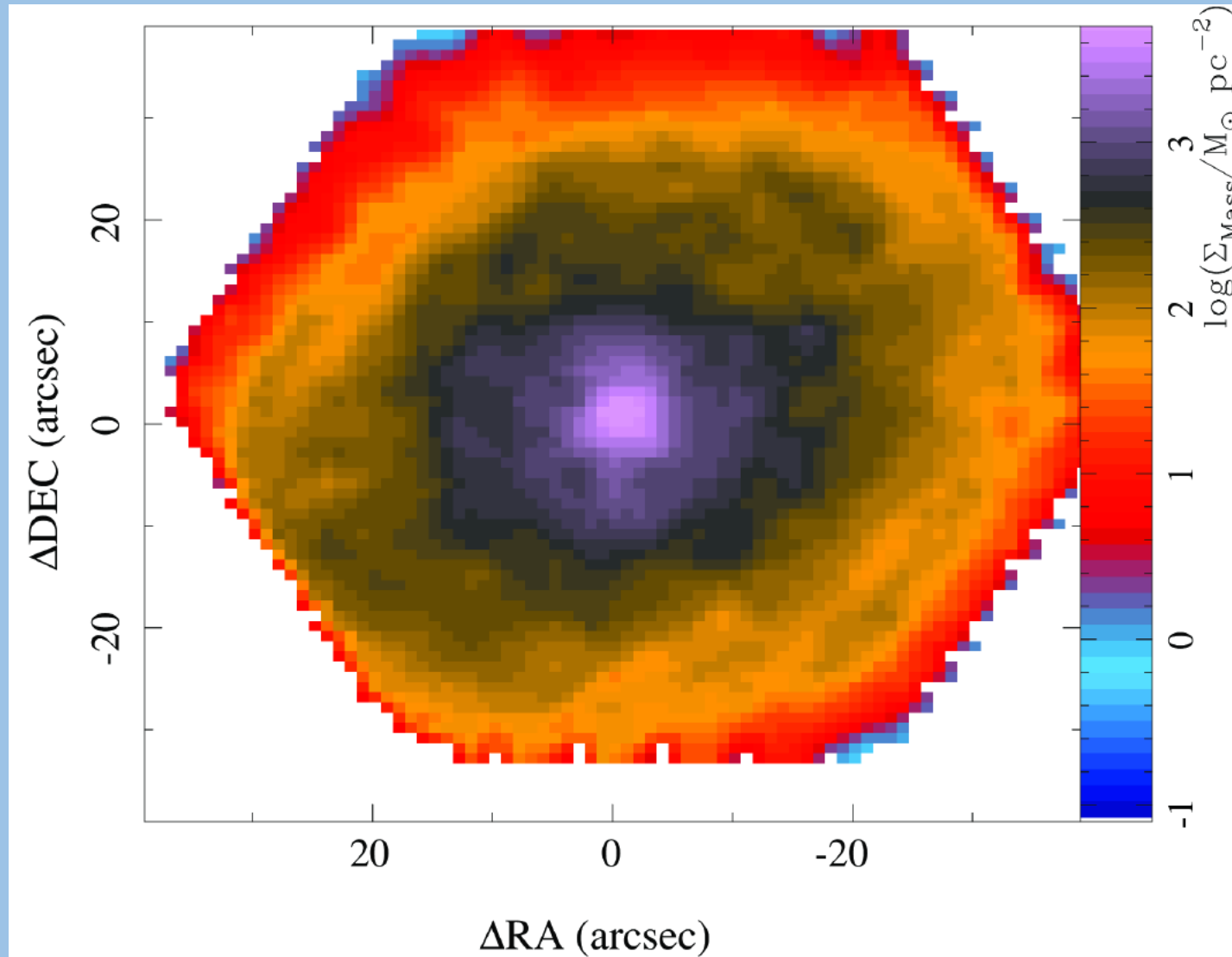
SDSS Bild

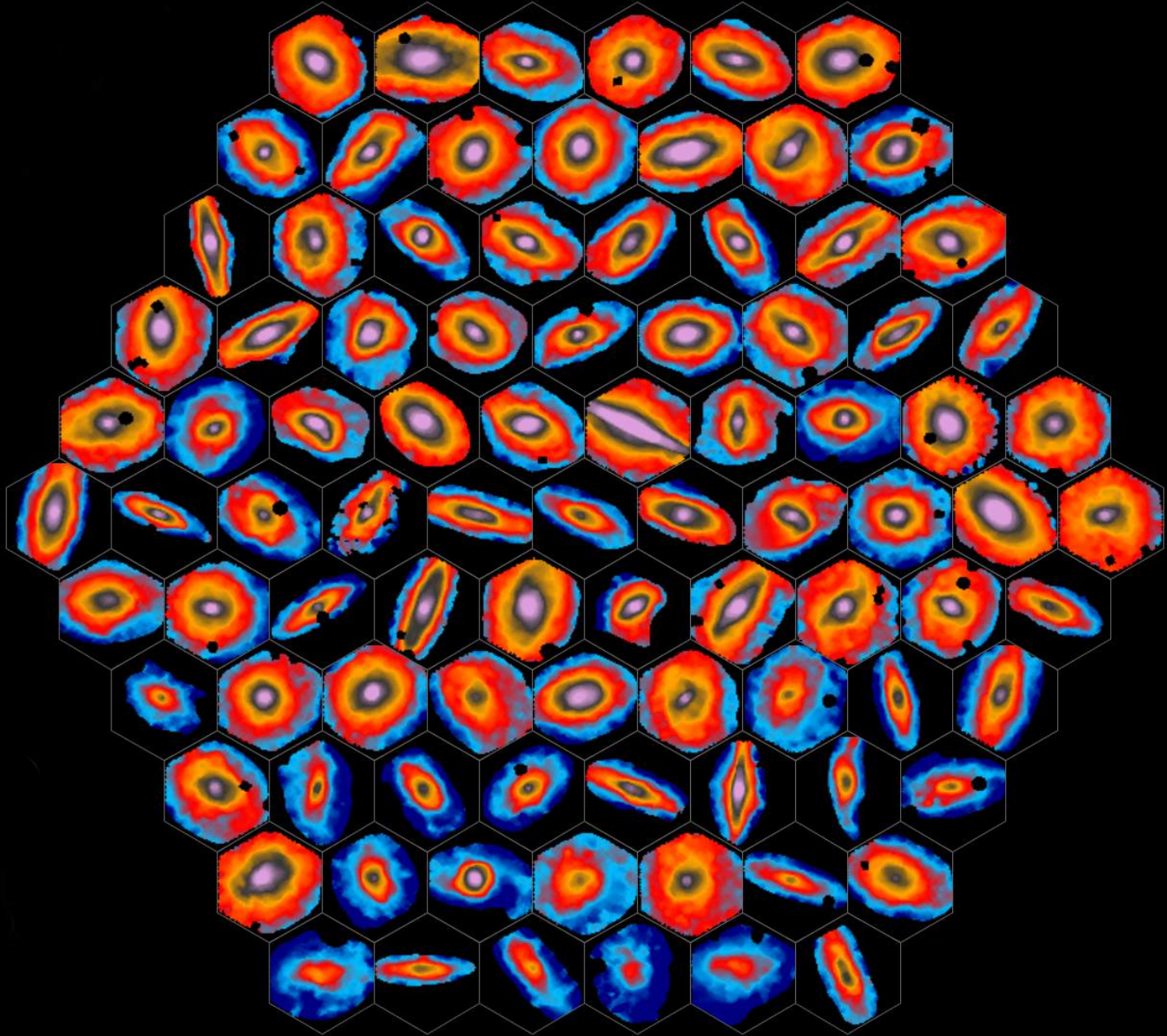


CALIFA Rekonstruktion

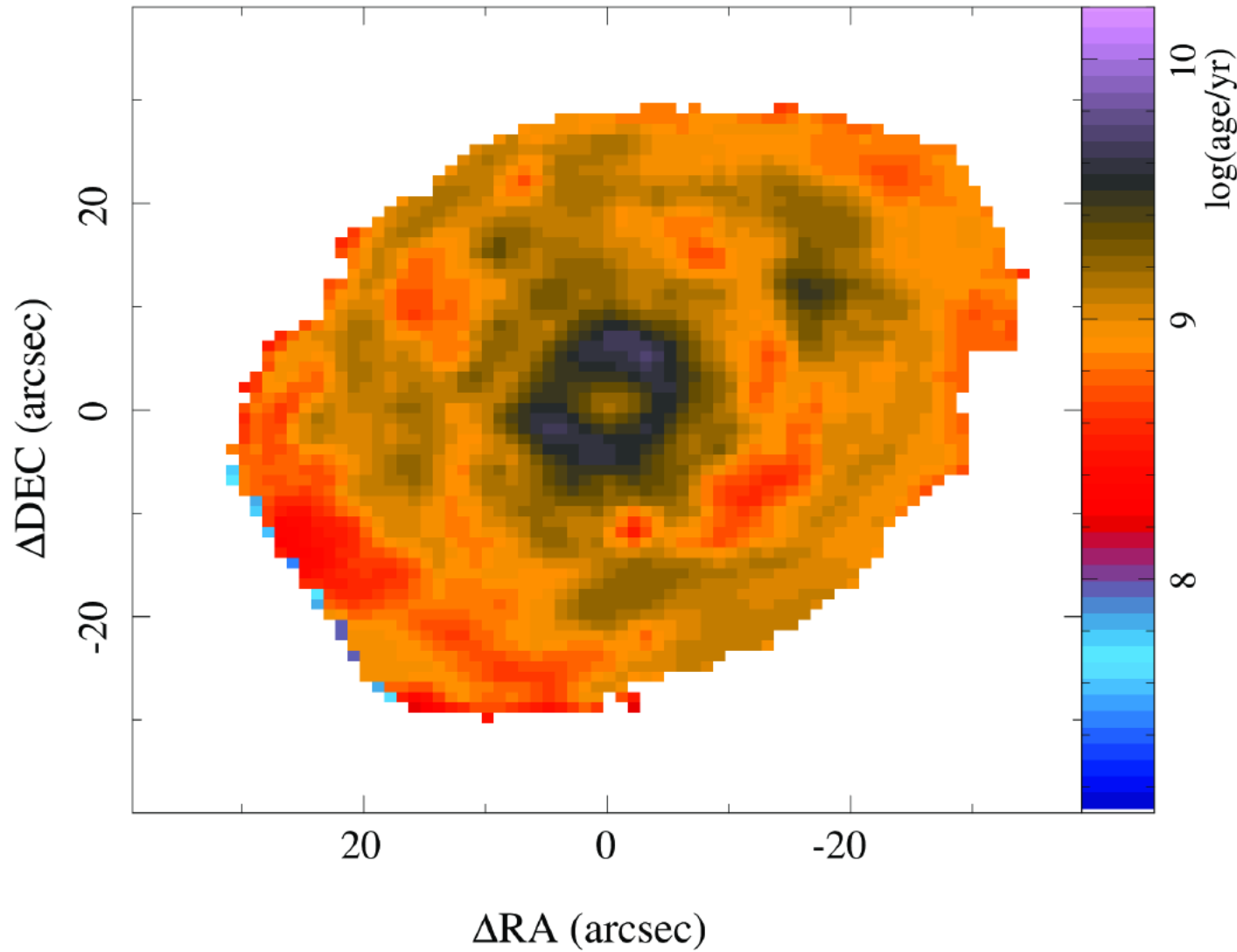


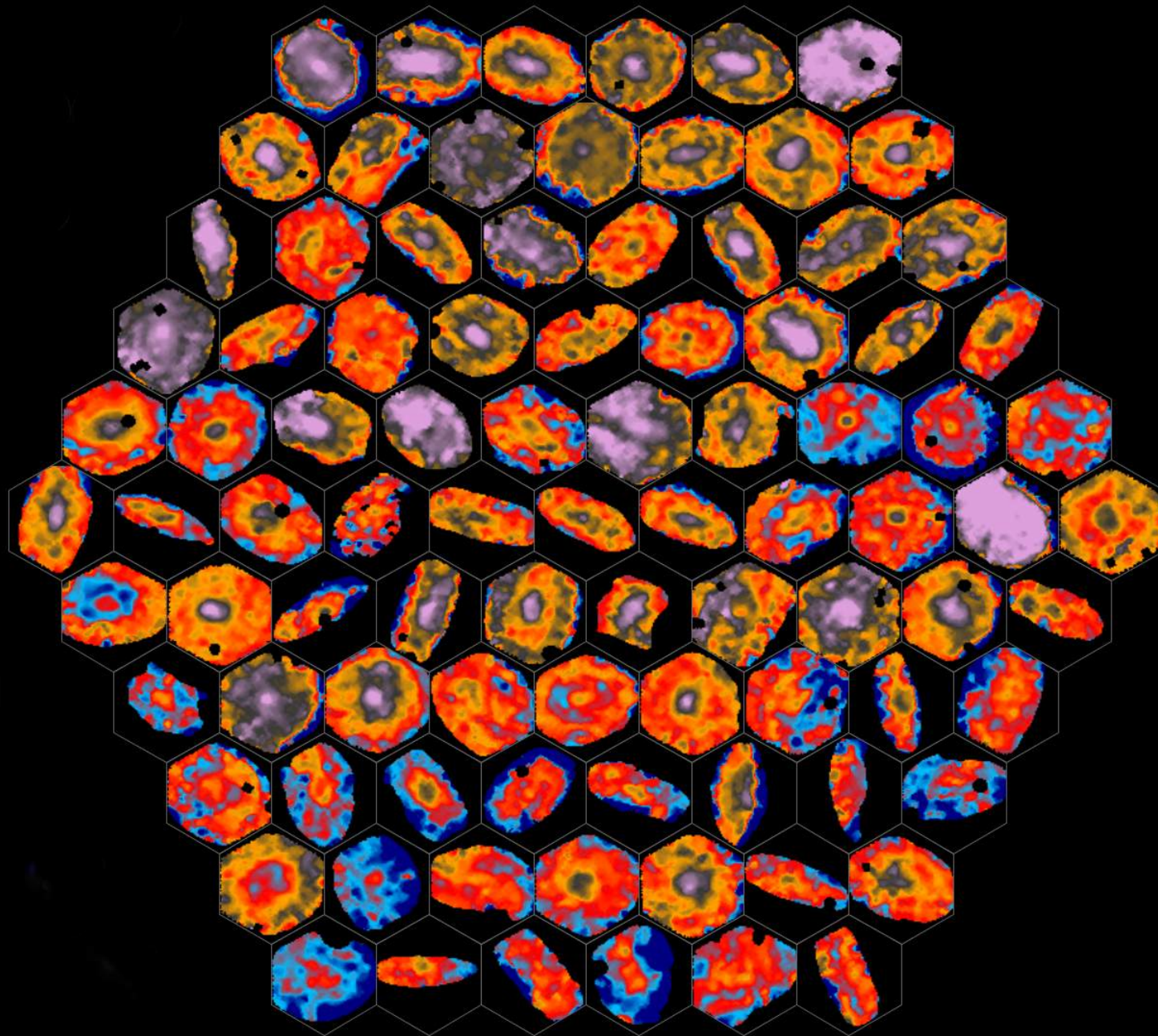
# Verteilung der stellaren Masse



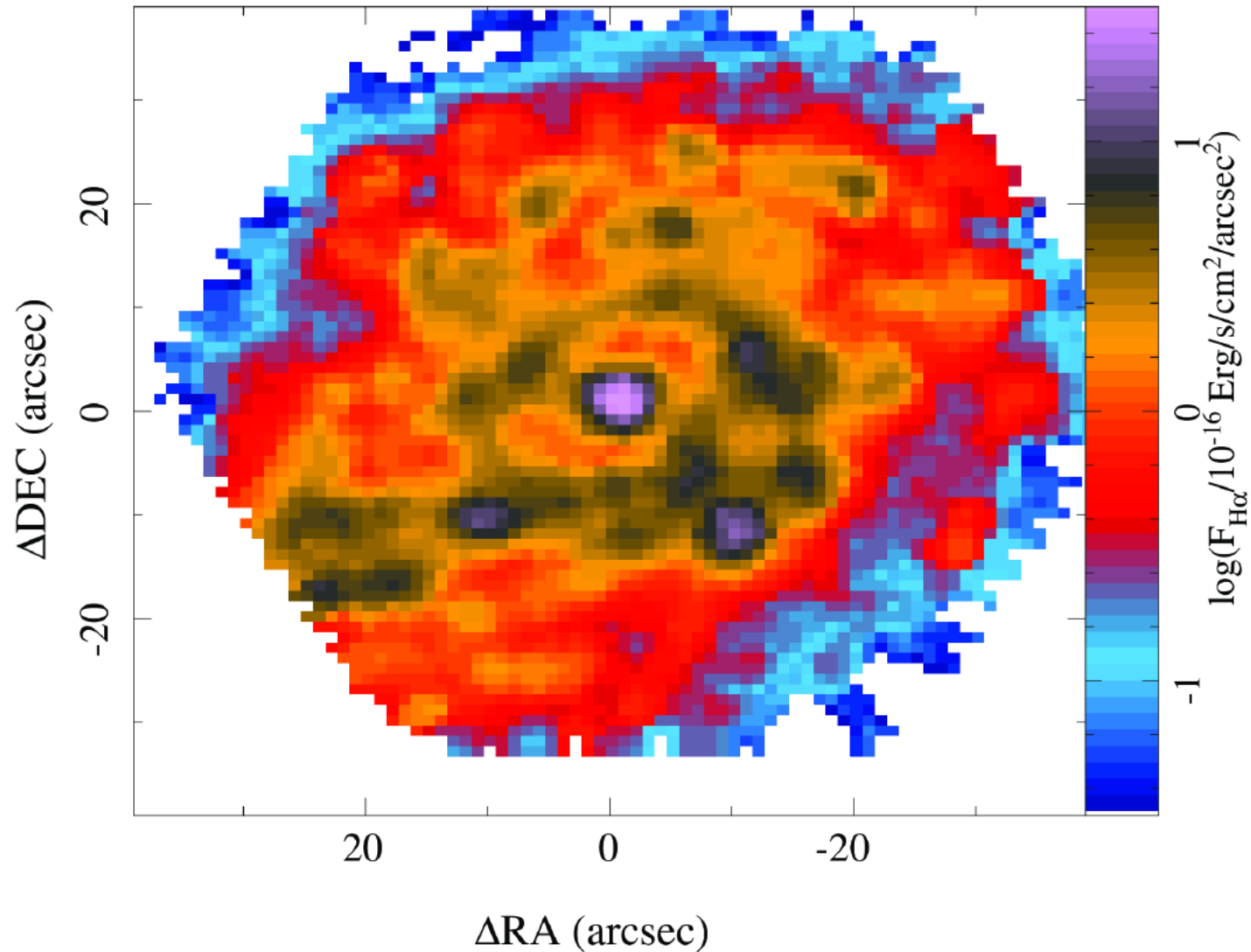


# Verteilung des stellaren Alters

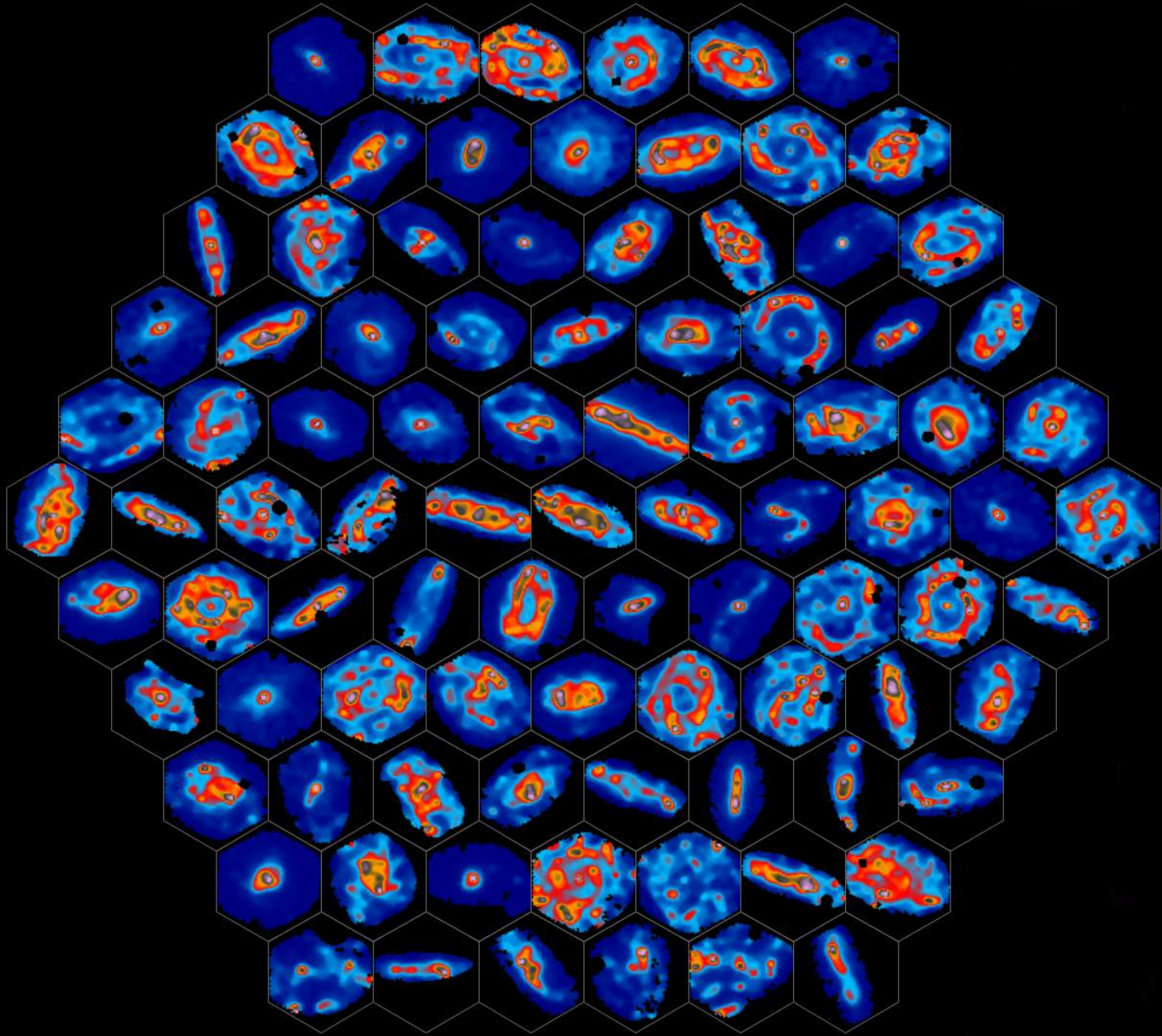




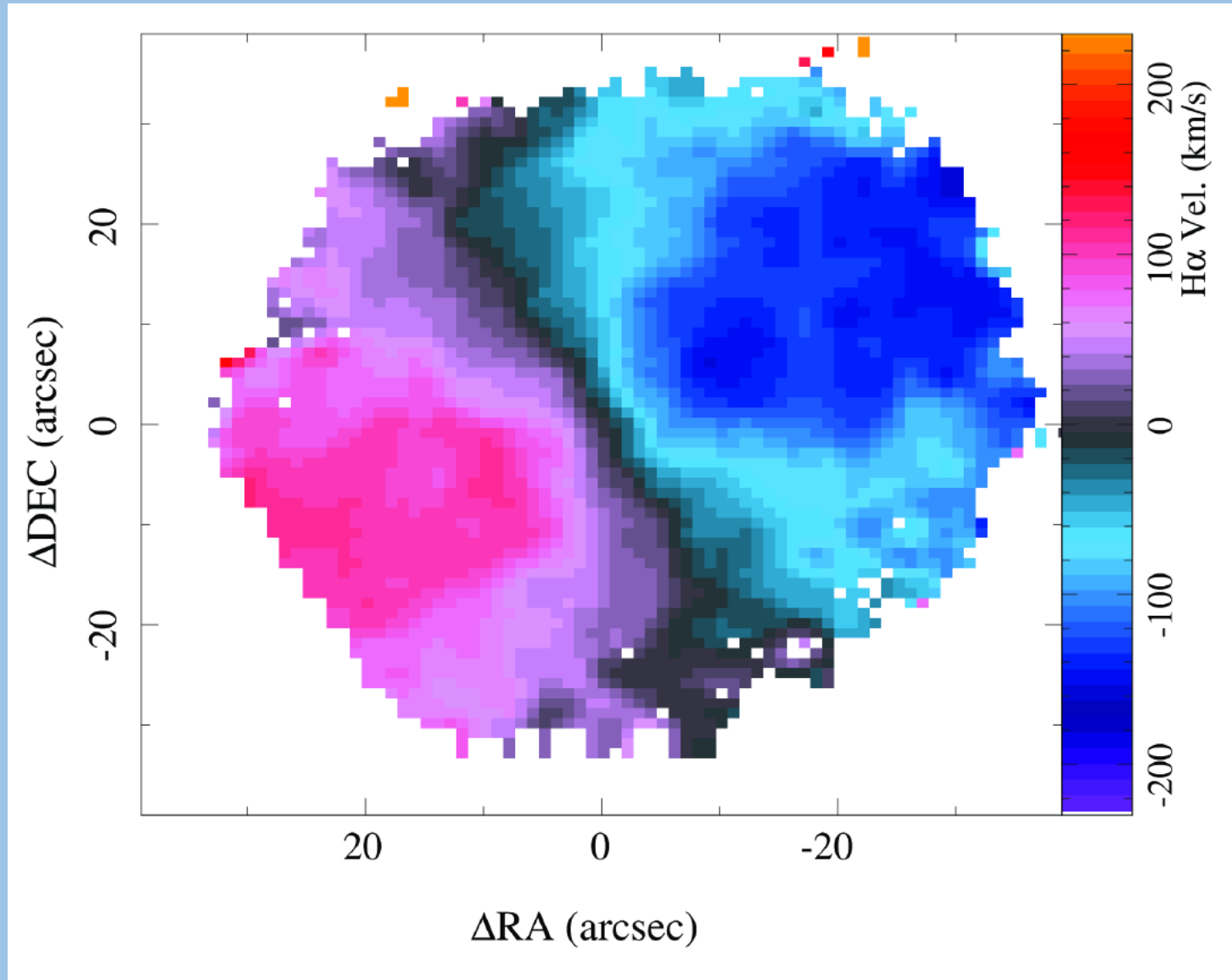
## Verteilung der momentanen Sternentstehung

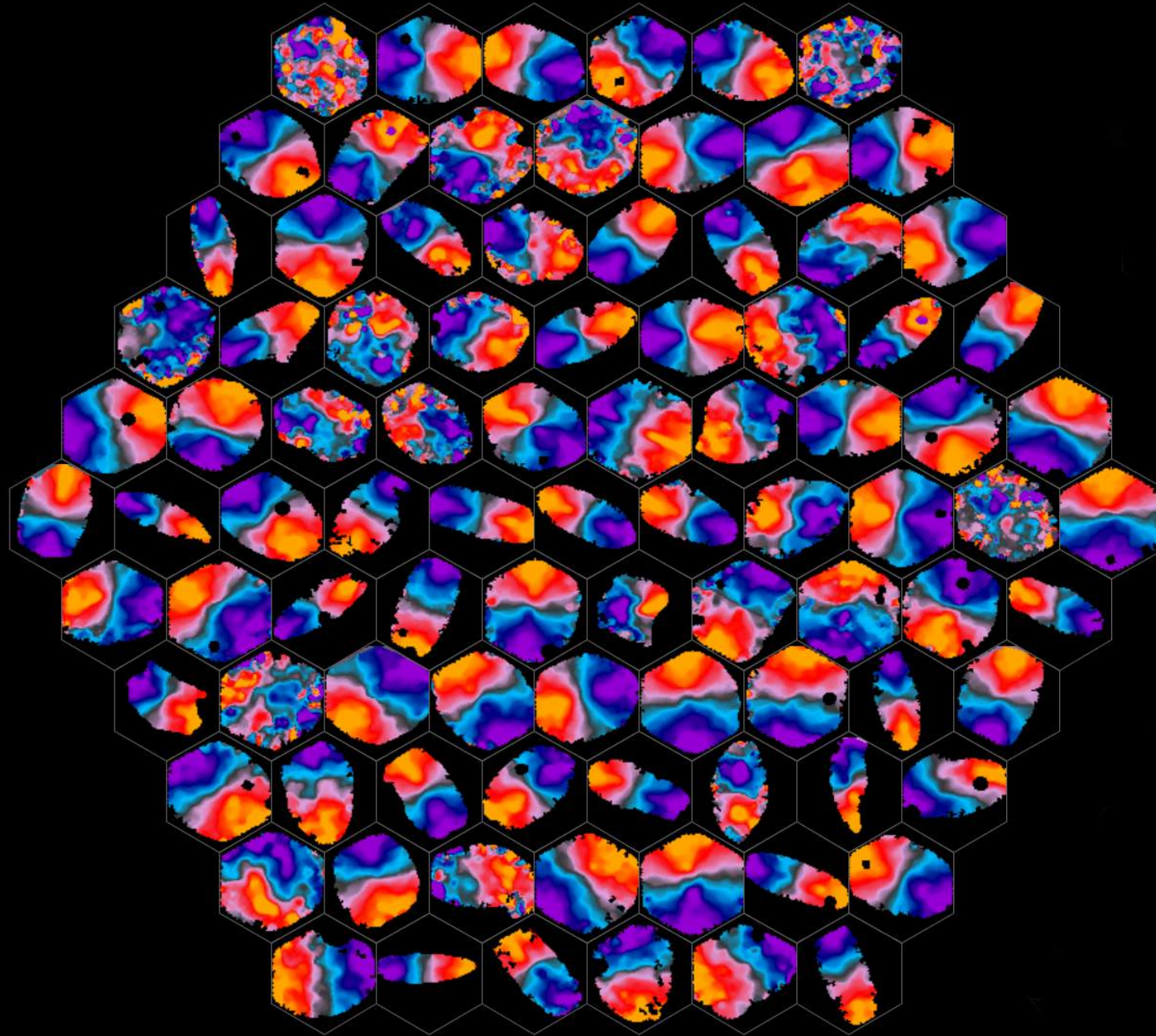




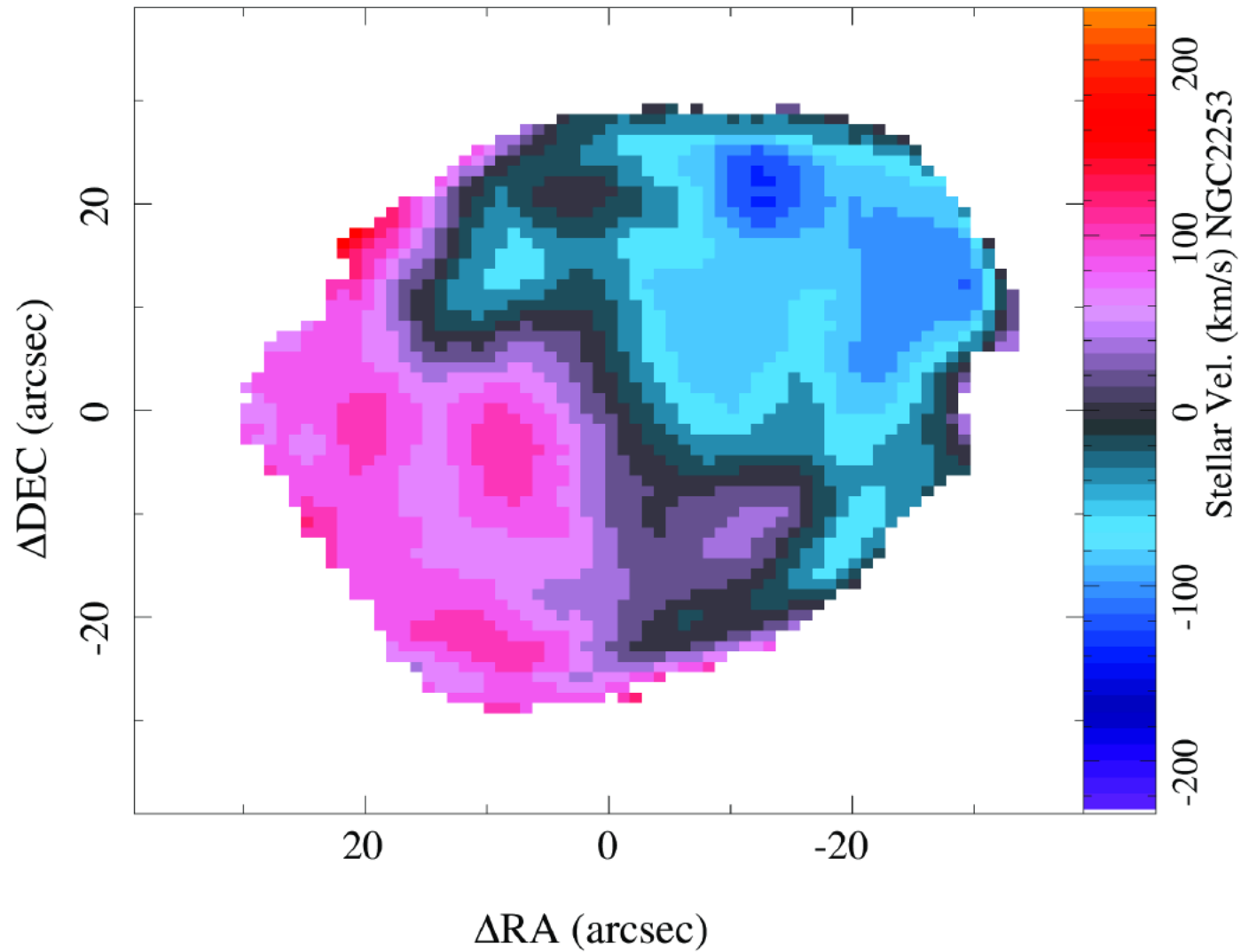


# Geschwindigkeitsfeld des Gases





# Geschwindigkeitsfeld der Sterne

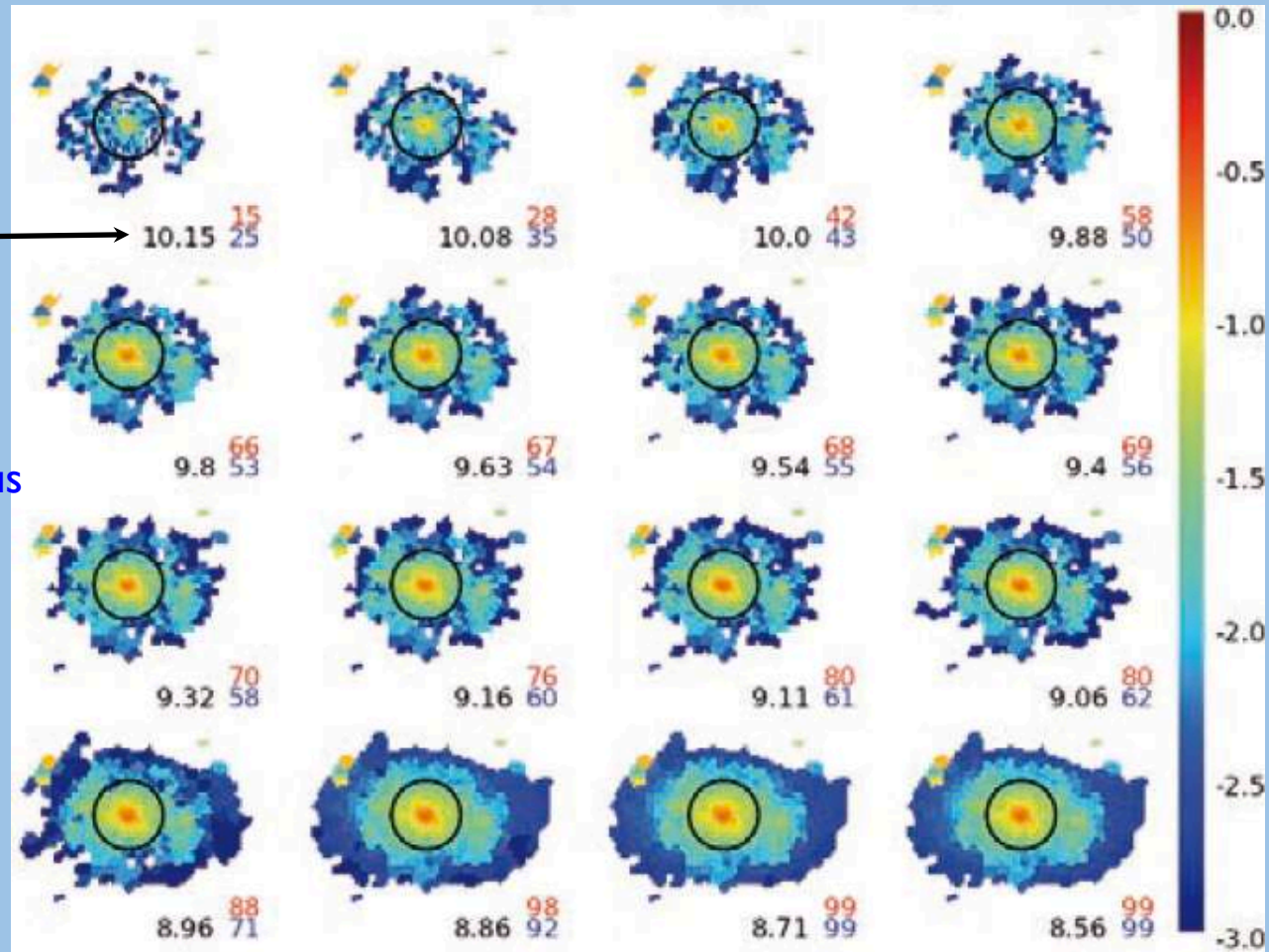


# Massen Wachstum

surface mass density  $M_{\text{sun}}/\text{pc}^2$

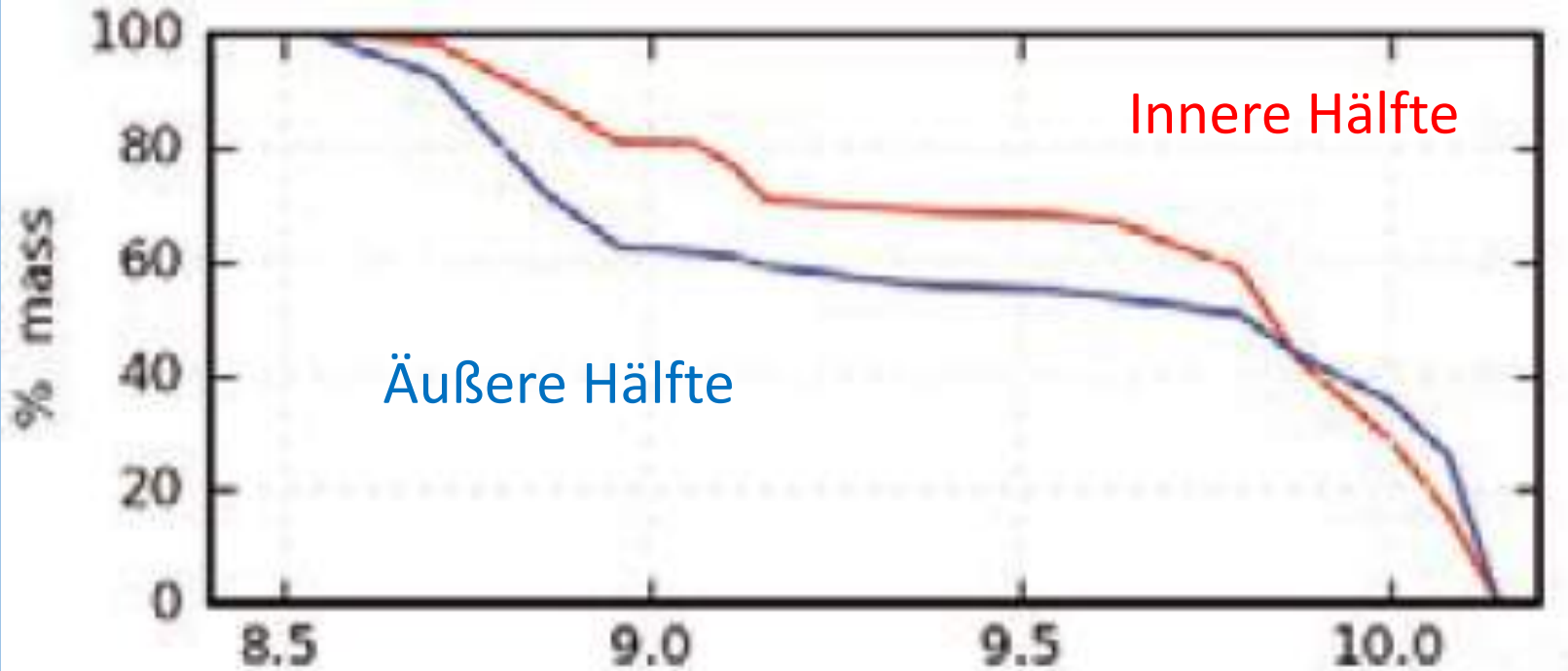
look-back time  $\log(t/\text{Gyr})$  →

inside current half-light radius  
outside current half-light radius



Pérez et al. (2013)

# Massen Wachstum



Van de Ven

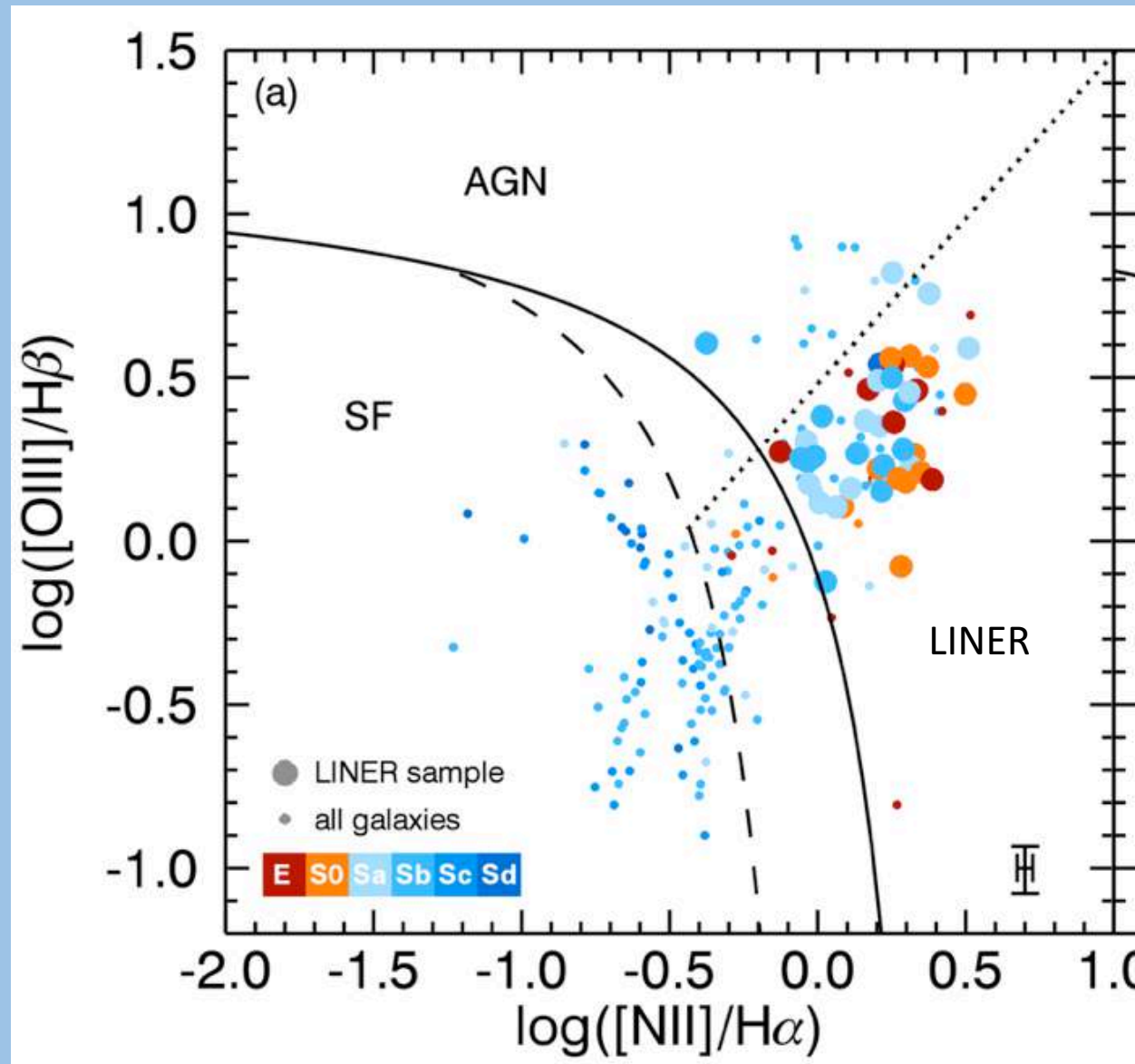
1 Mrd

10 Mrd Jahre

Rückblickzeit ->

# Inside-out Growth

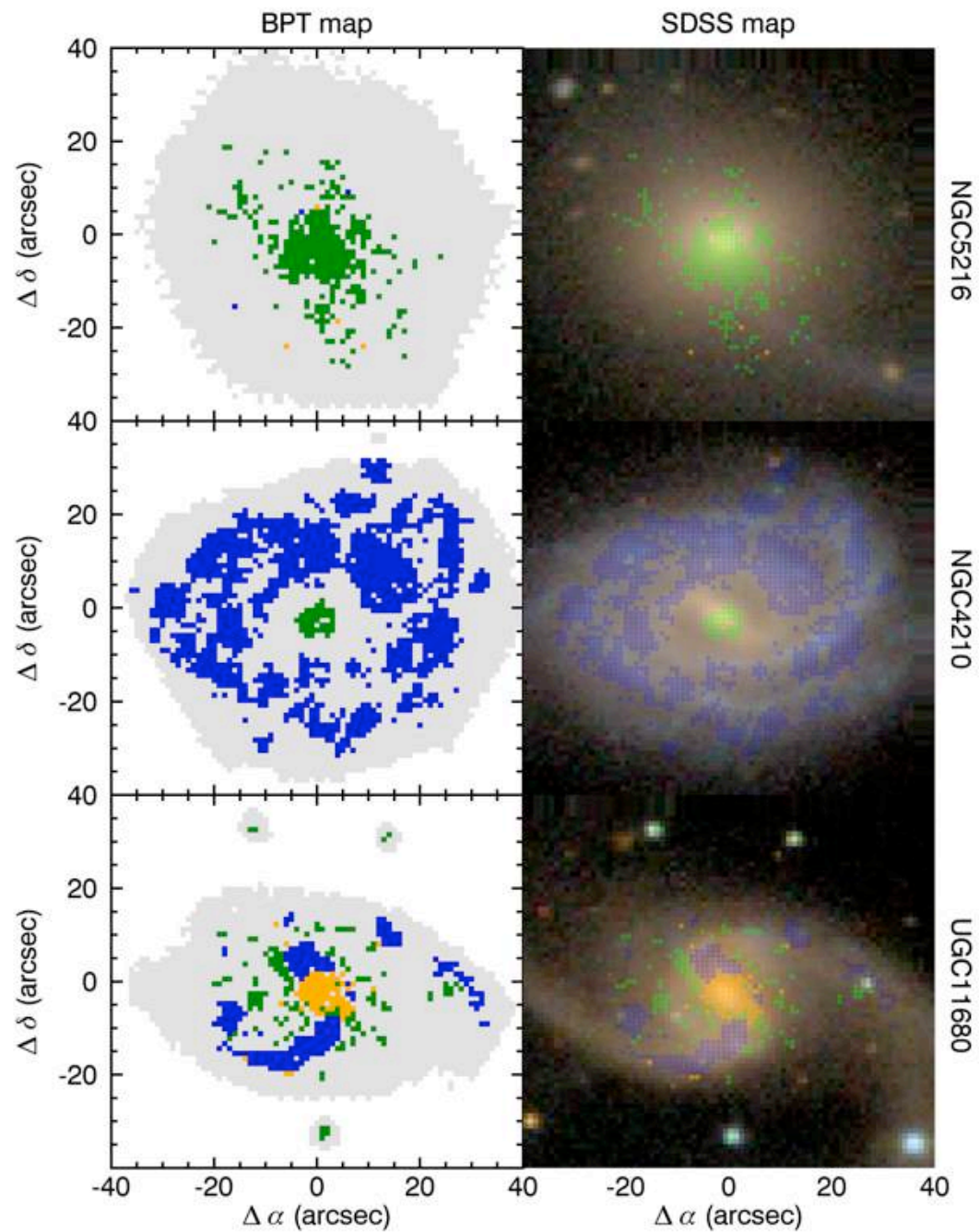
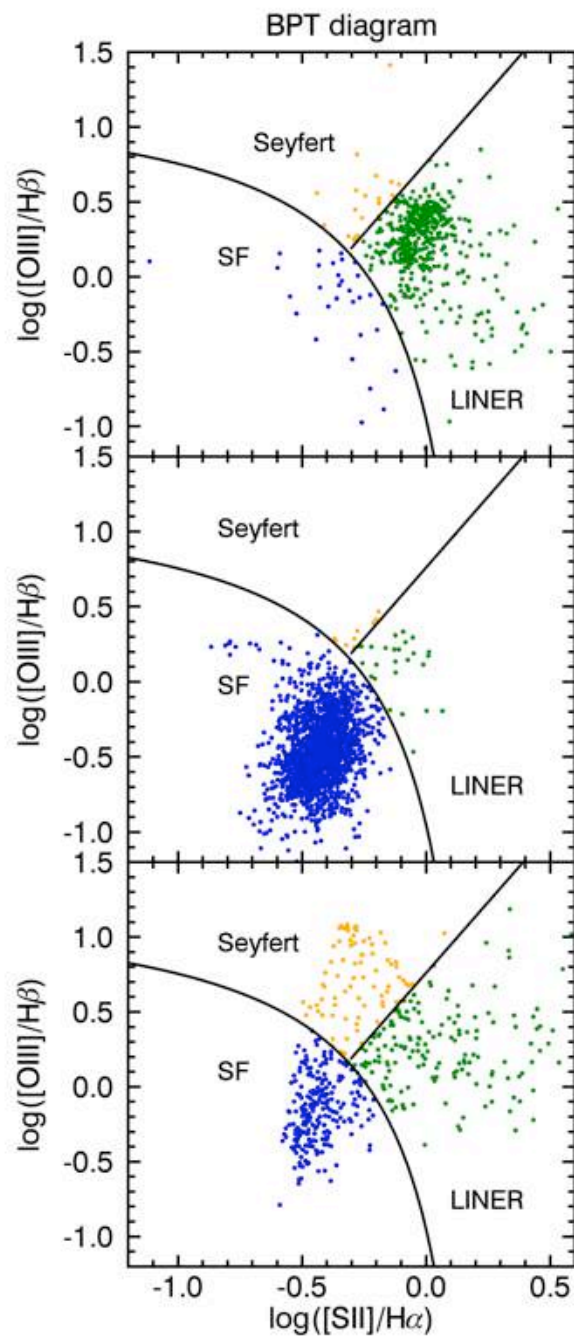
# Ionizing Sources: SF, AGN, LINER



low-ionization **nuclear**  
emission-line region

Aktive  
Schwarze  
Löcher ?

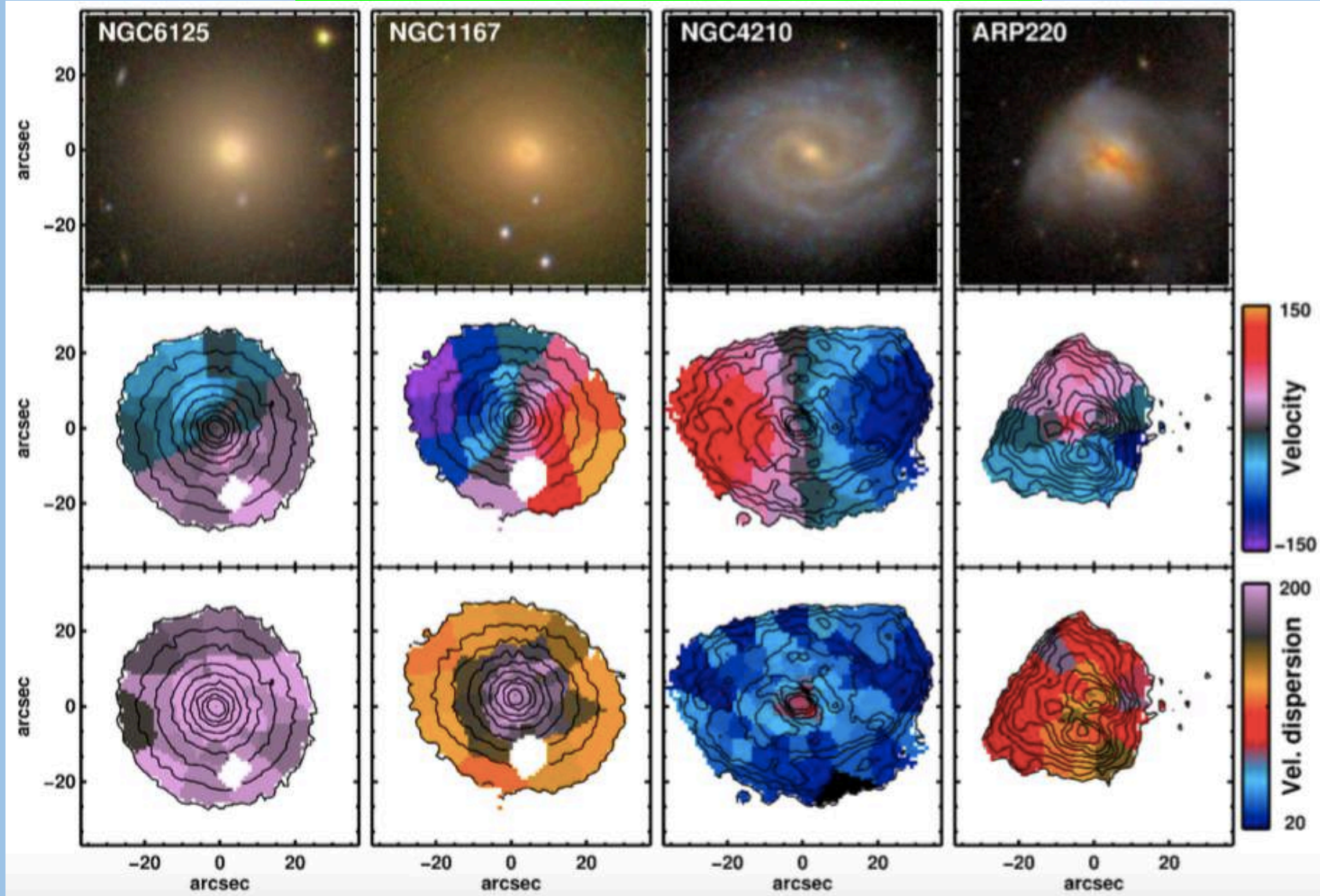
LINERs  
are  
LIERs !





Rotation

Chaos



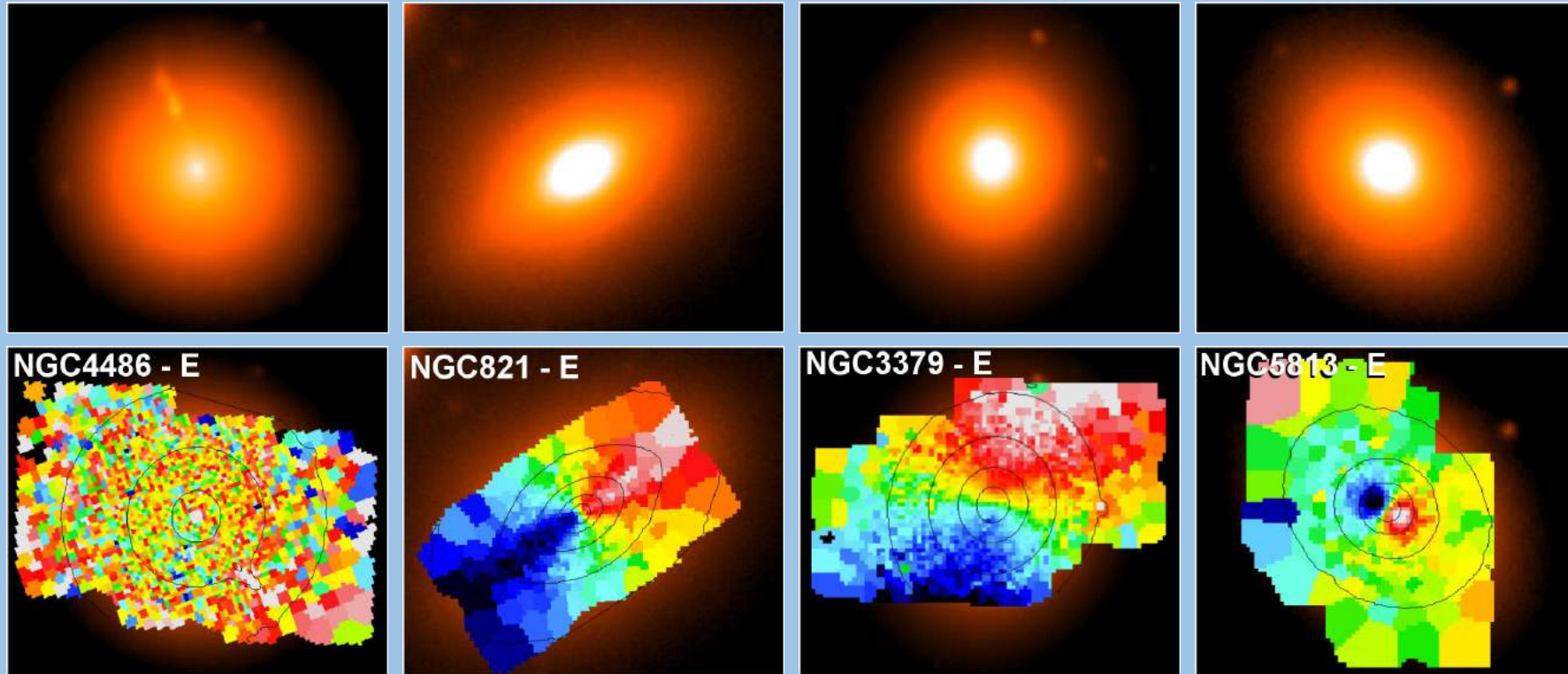
Slow Rotator  
(low  $V$ , high  $\sigma$ )

Bulge + Disk  
(high  $V$ , high  $\sigma$ )

Pure disk  
(high  $V$ , low  $\sigma$ )

Interacting  
(e.g. ARP220)

# Stellare Kinematik der Elliptischen Galaxien

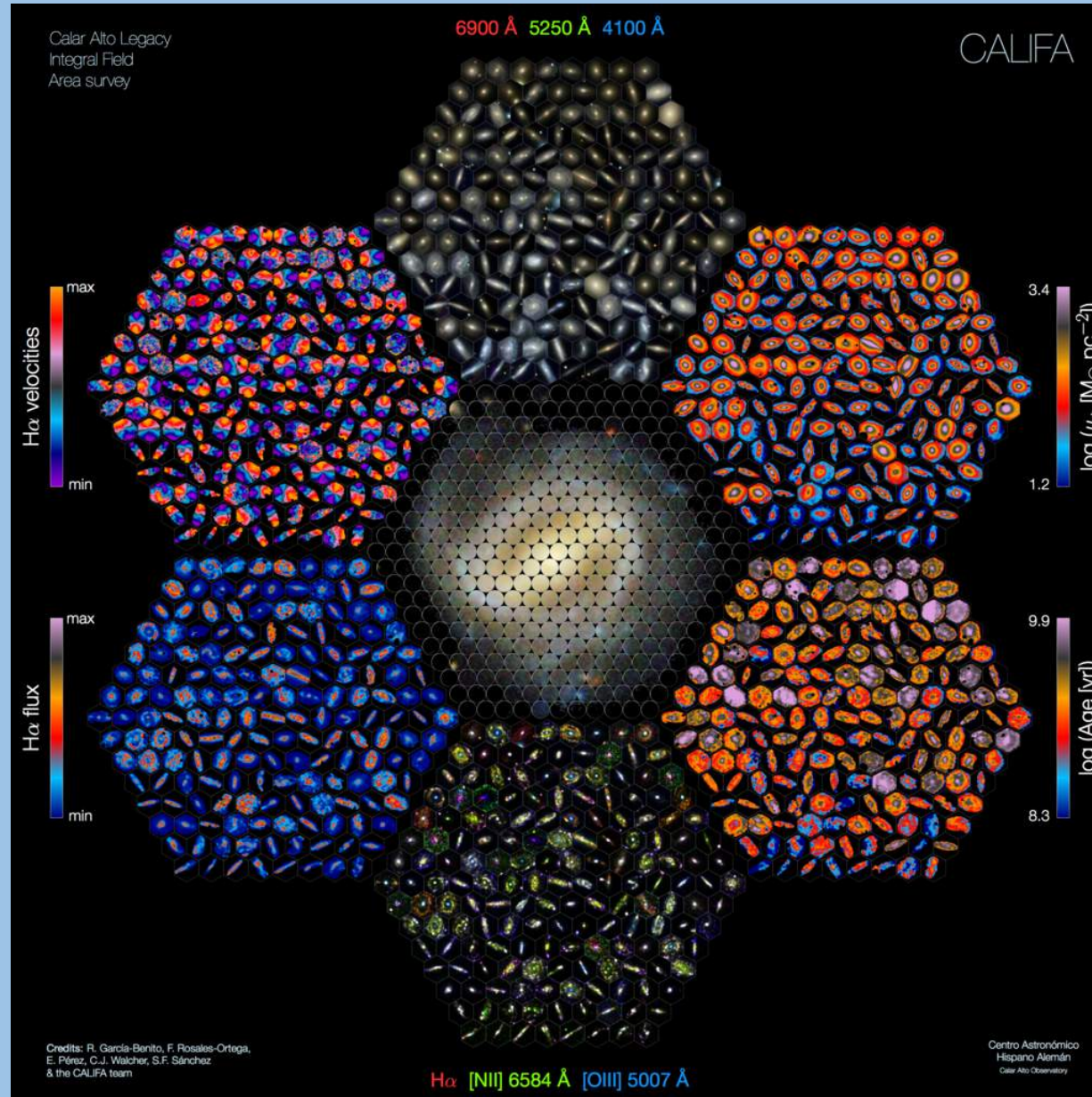


Elliptische Galaxien haben ähnliche Struktur (Aussehen),  
aber ganz verschiedene Kinematik (Geschwindigkeitsfelder),  
sind also physikalisch vielfältige Objekte.

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