# A Method to Distinguish **Quiescent** and **Dusty Star-forming** Galaxies **with t-SNE**

## John R. Weaver
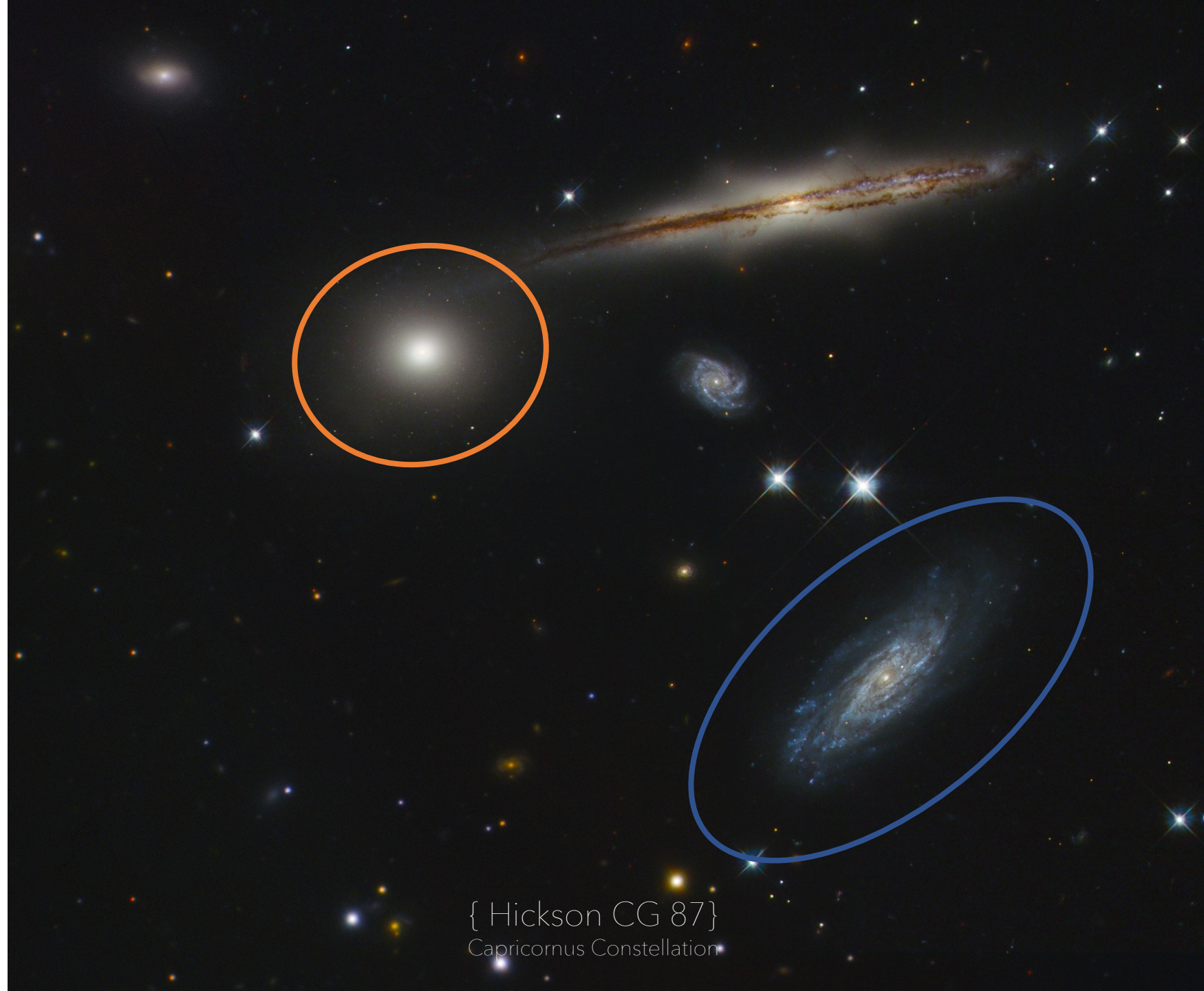
PhD Fellow @ The Cosmic Dawn Center
Niels Bohr Institute

Charles L. **Steinhardt** (DAWN)
Jack **Maxfield** (Caltech)
Iary **Davidzon** (DAWN)
Dan **Masters** (Caltech/JPL)
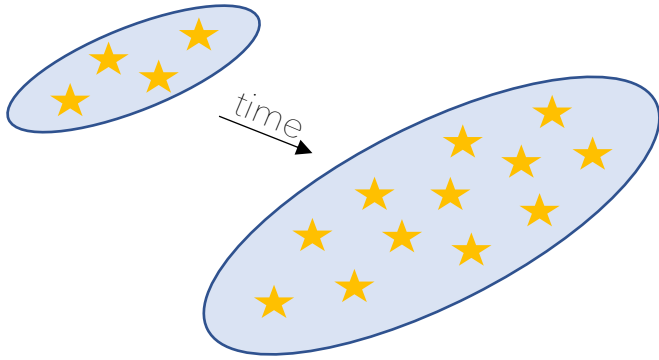Madeline **Schemel** (Caltech)
Sune **Toft** (DAWN)

{ Hickson CG 87}
Capricornus Constellation

DAWN

JPL Caltech
Jet Propulsion Laboratory
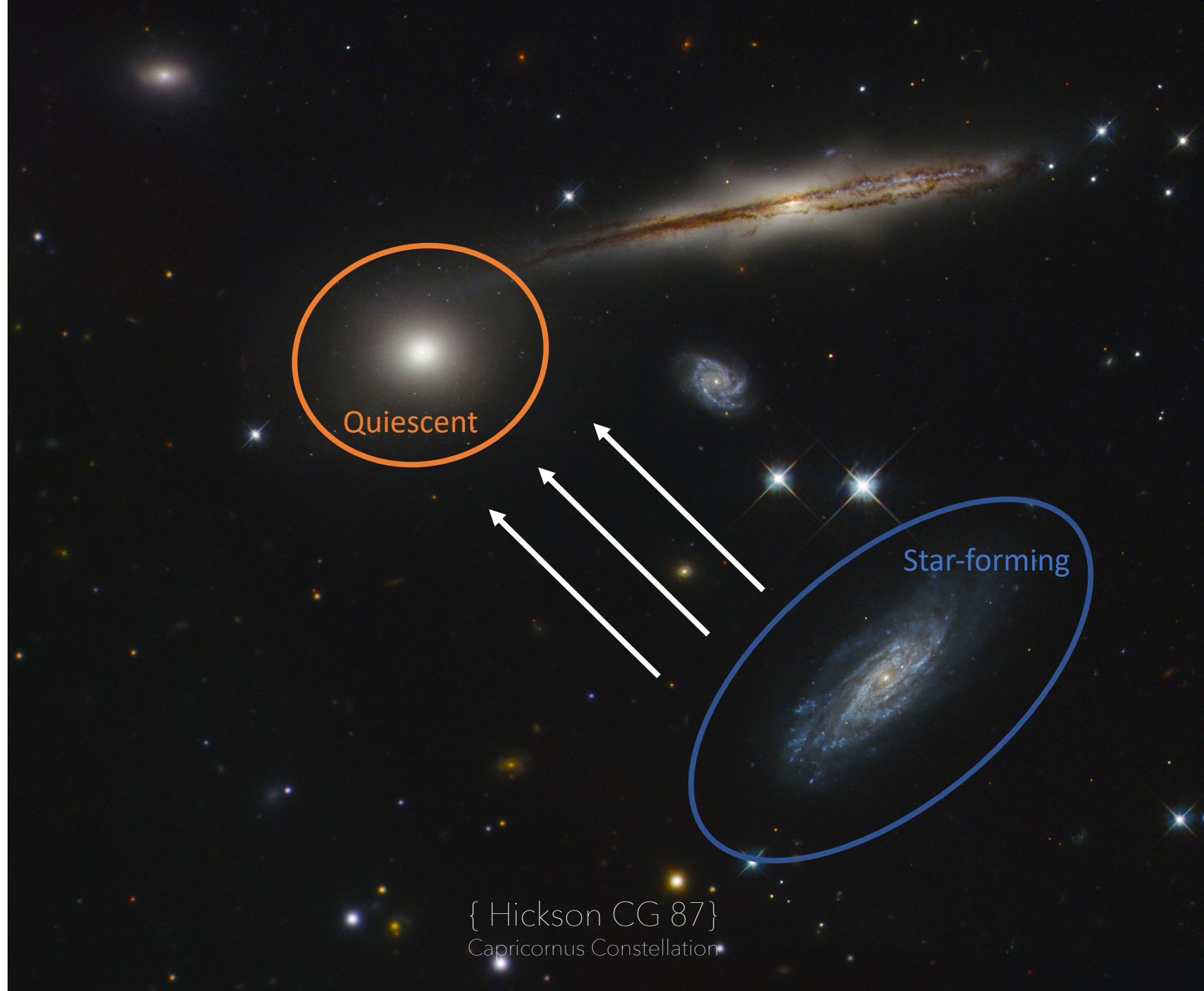
# The Current Paradigm

Galaxies grow by forming stars



*time*
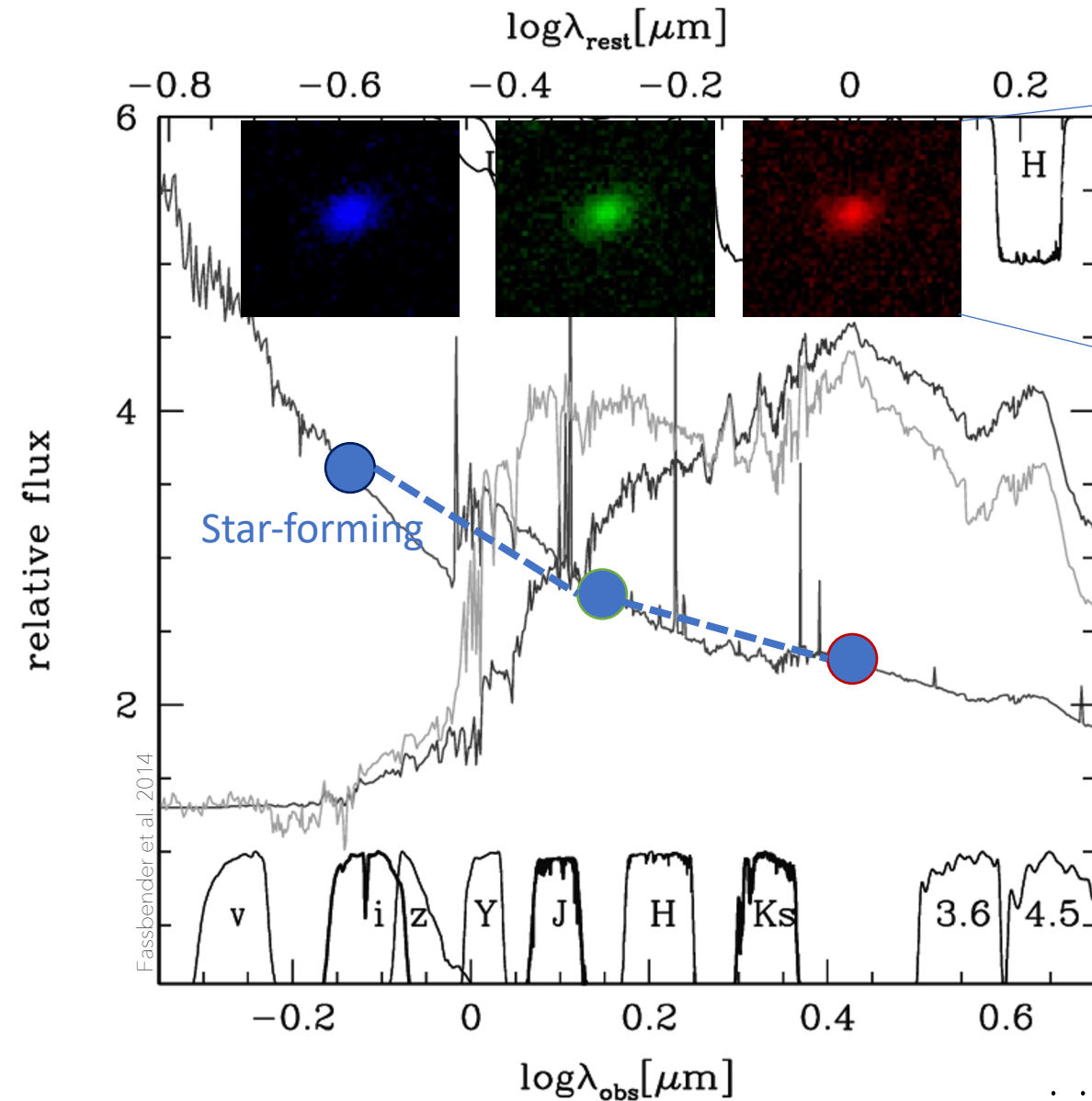
Sometimes they cease forming stars



*time*
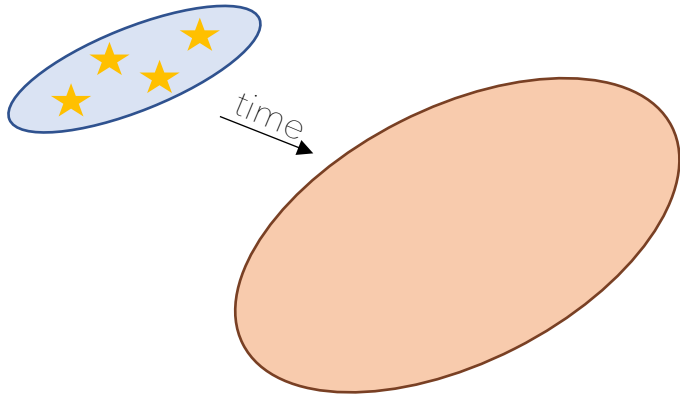
We want to find <u>both kinds</u> to understand why!



Quiescent

Star-forming

{ Hickson CG 87}
Capricornus Constellation

# We cannot resolve distant galaxies…


Distant


Nearby

# We cannot resolve distant galaxies...



Star-forming

Fassbender et al. 2014

relative flux

$\log\lambda_{rest}[\mu m]$

$\log\lambda_{obs}[\mu m]$

Distant

Nearby
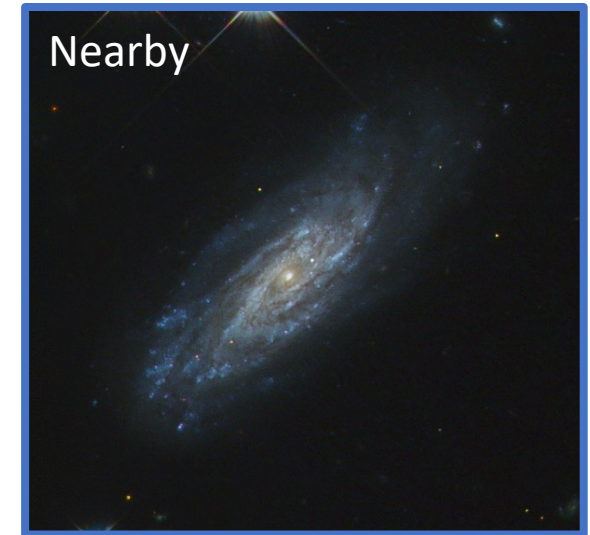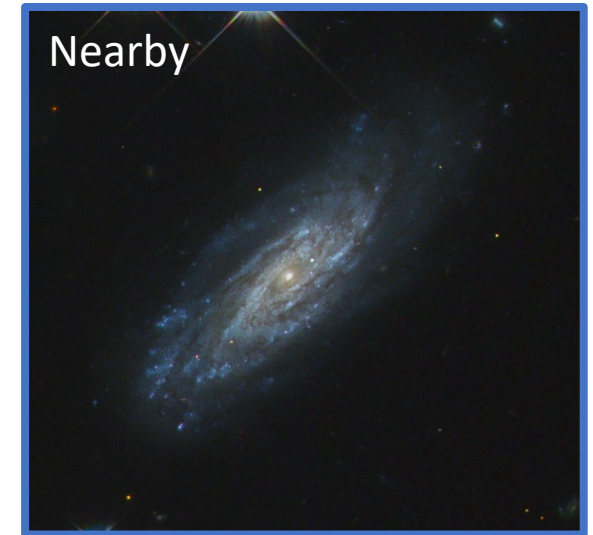
... but we can capture their light!

# We cannot resolve distant galaxies…



Fassbender et al. 2014

Star-forming
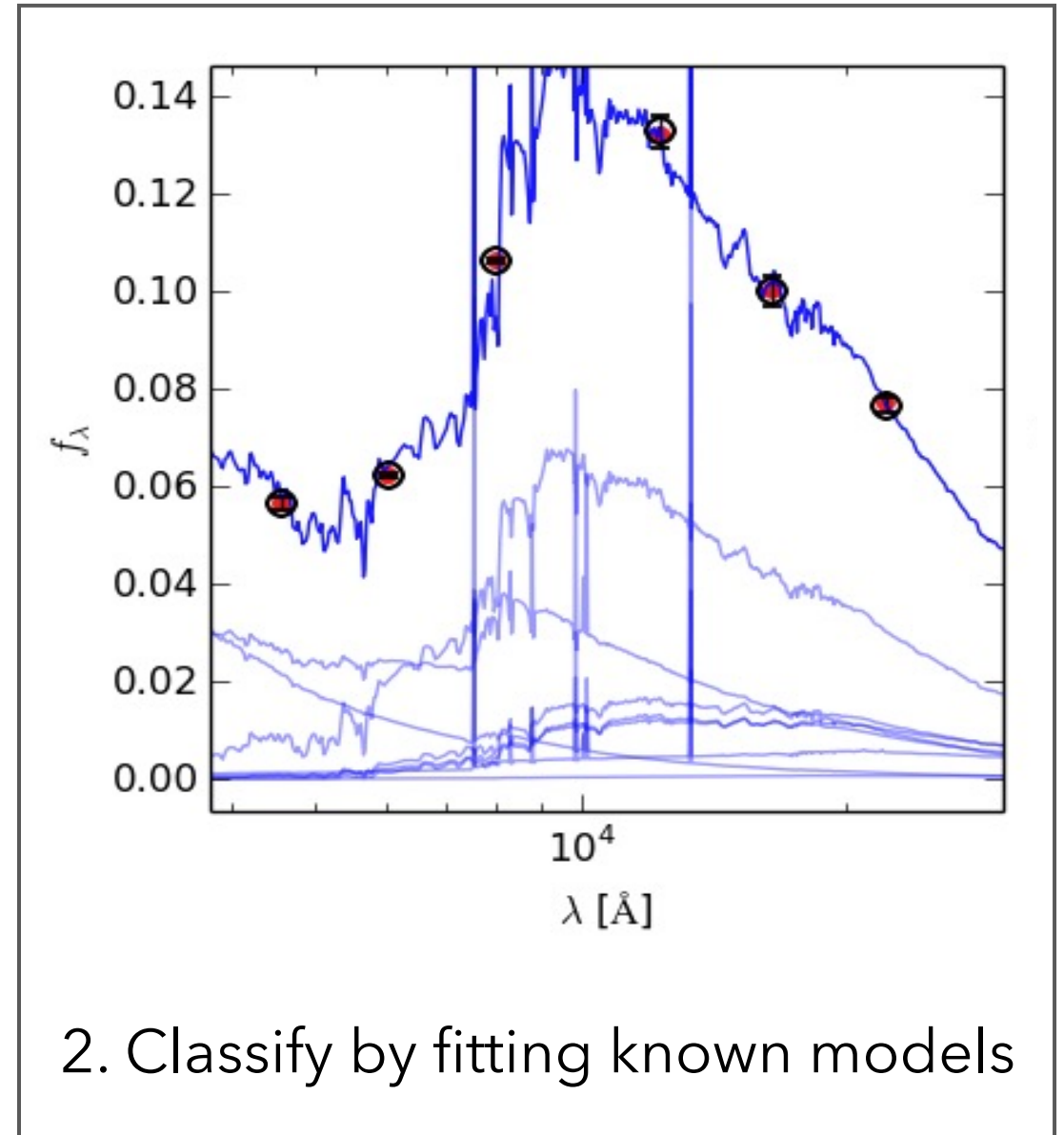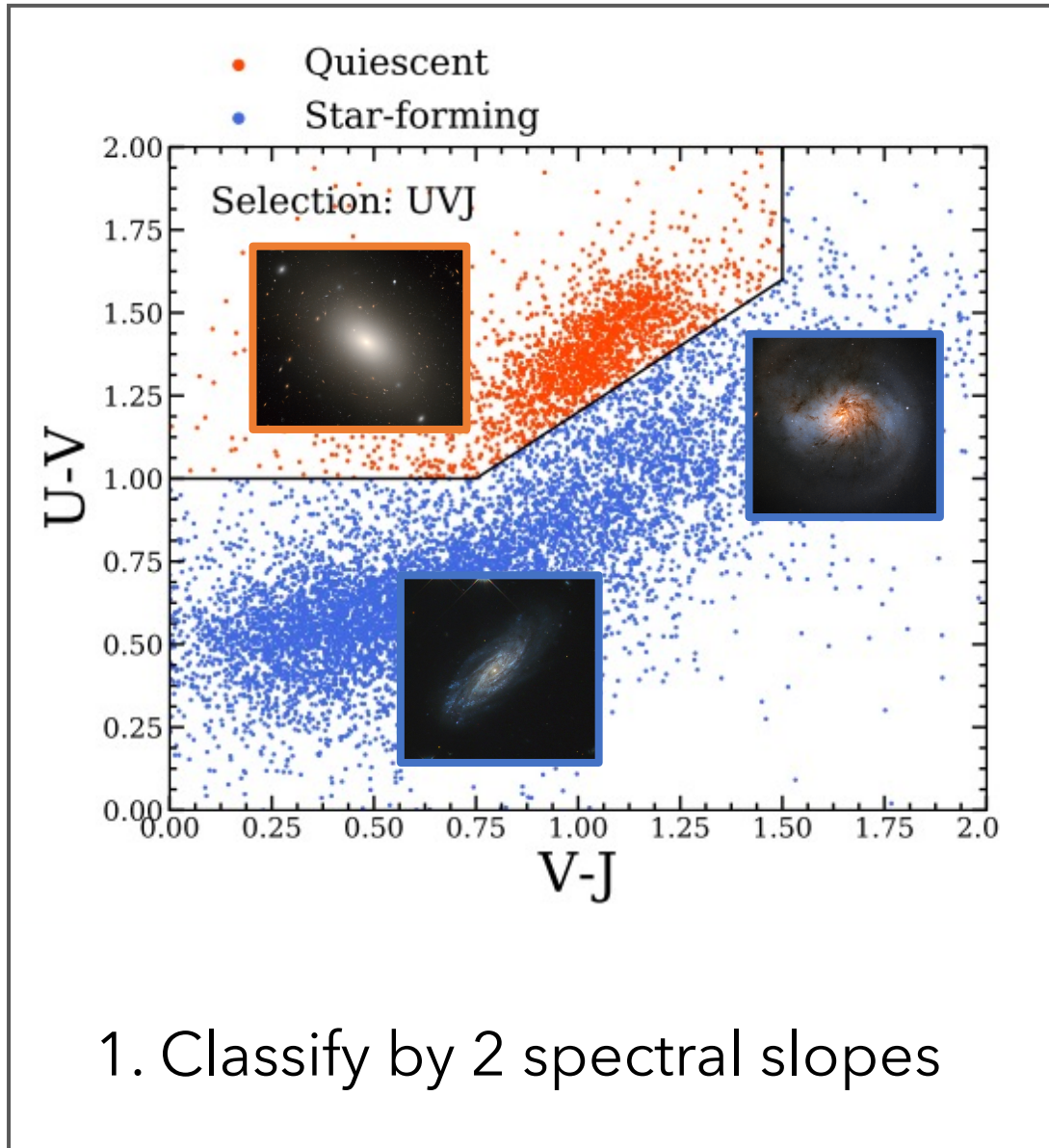
Quiescent

Distant

Nearby
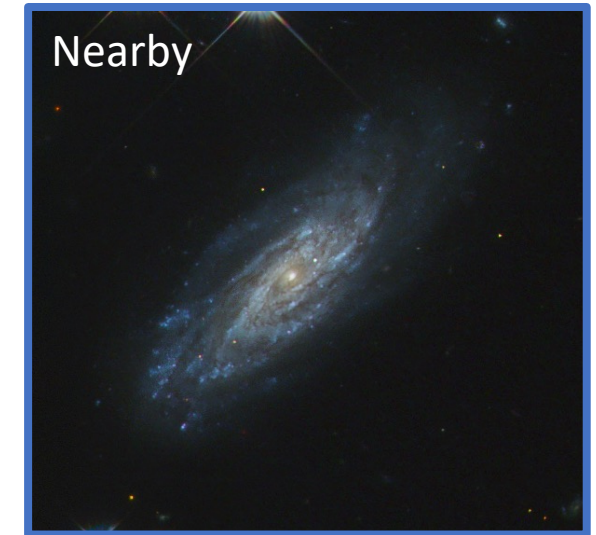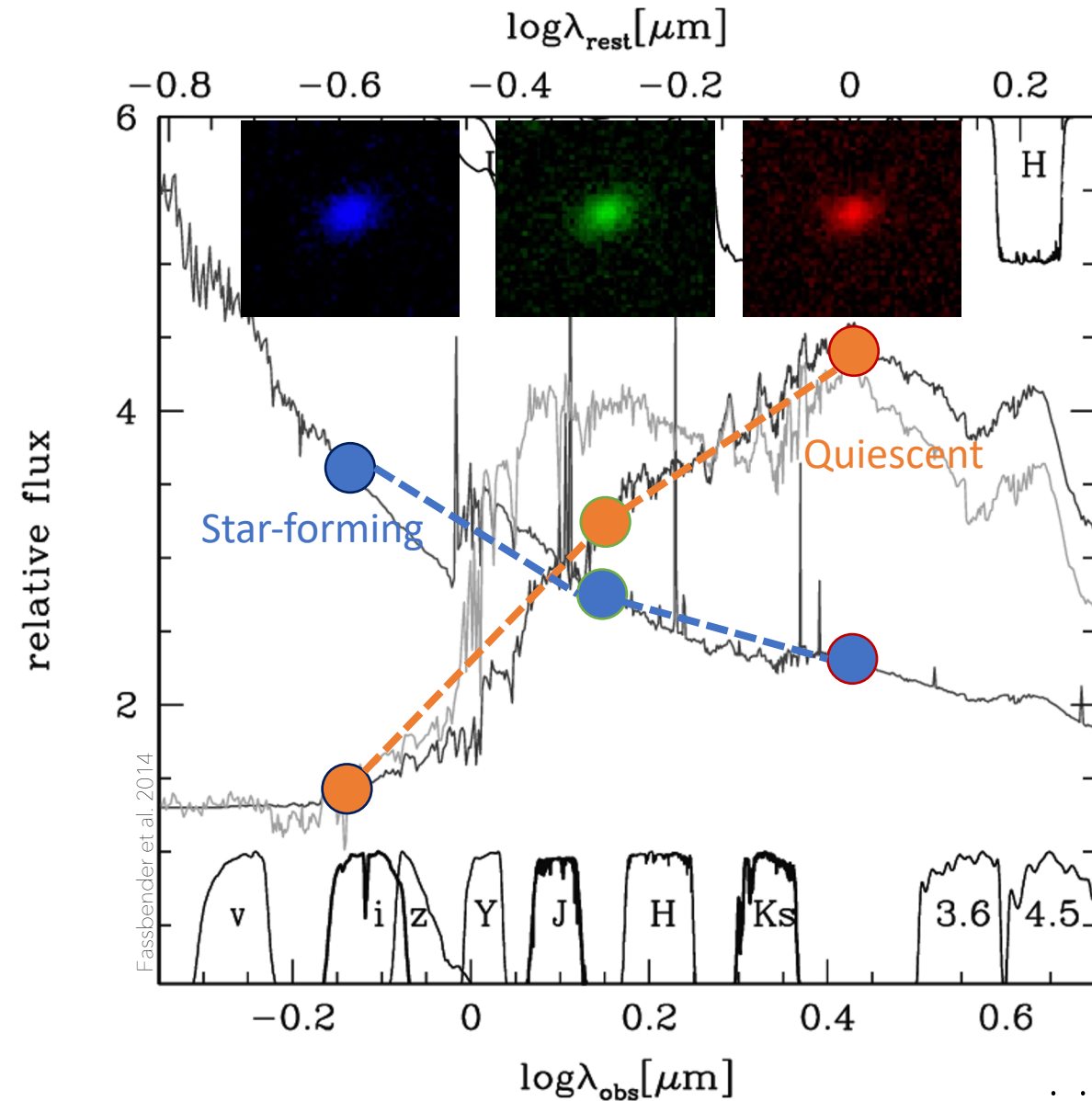
… but we can capture their light!

# The Problem: But if you add dust...
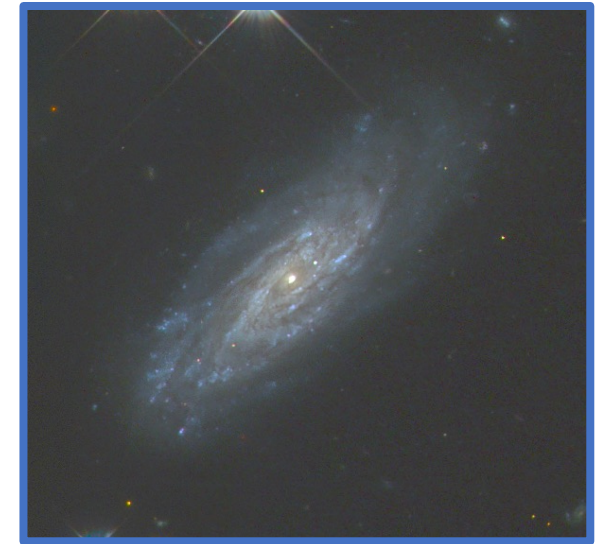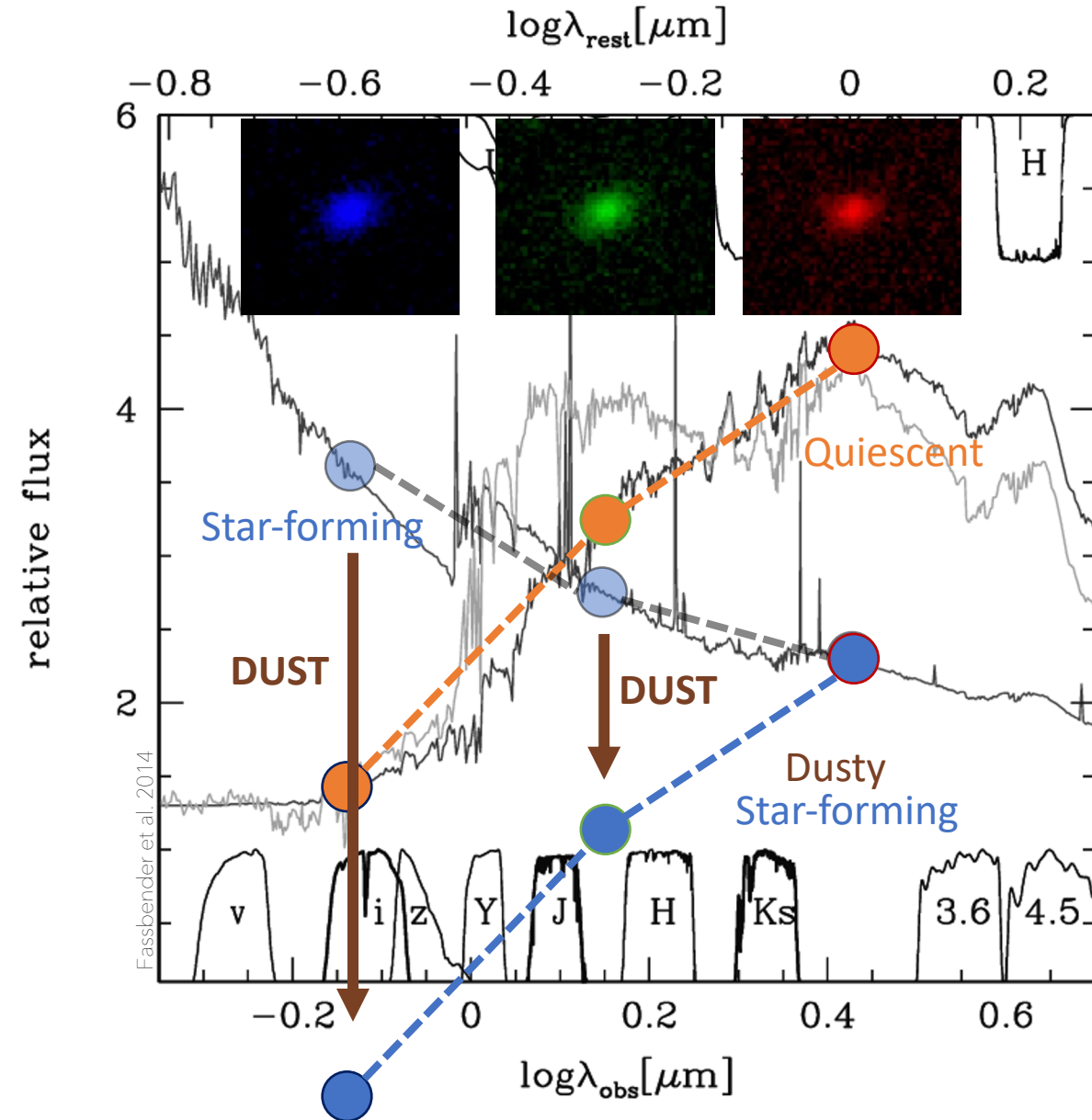


... their light looks the same!

# Traditional approaches:



1. Classify by 2 spectral slopes

2. Classify by fitting known models

# Application of t-SNE

## We gave t-SNE 1,000+ photometric measurements of spectra



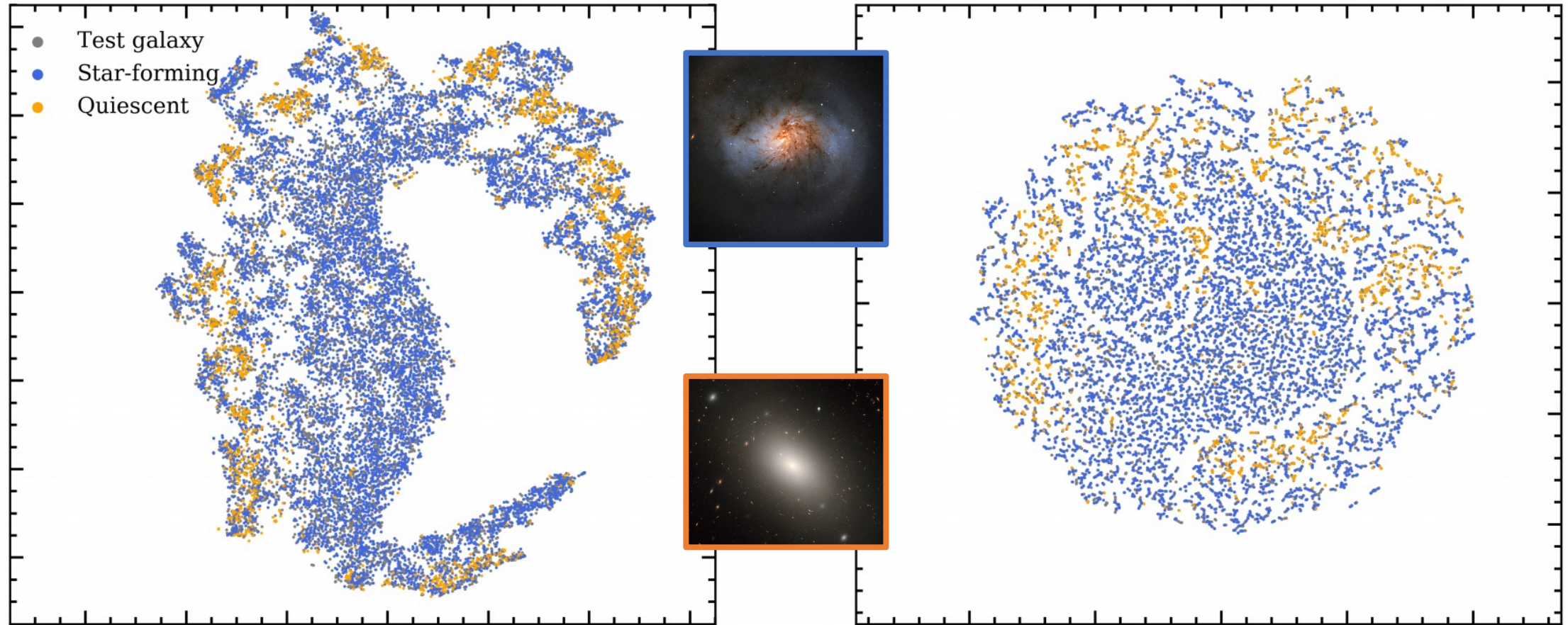Data: COSMOS2015 (Laigle et al. 2016)

Wavelength (Å)
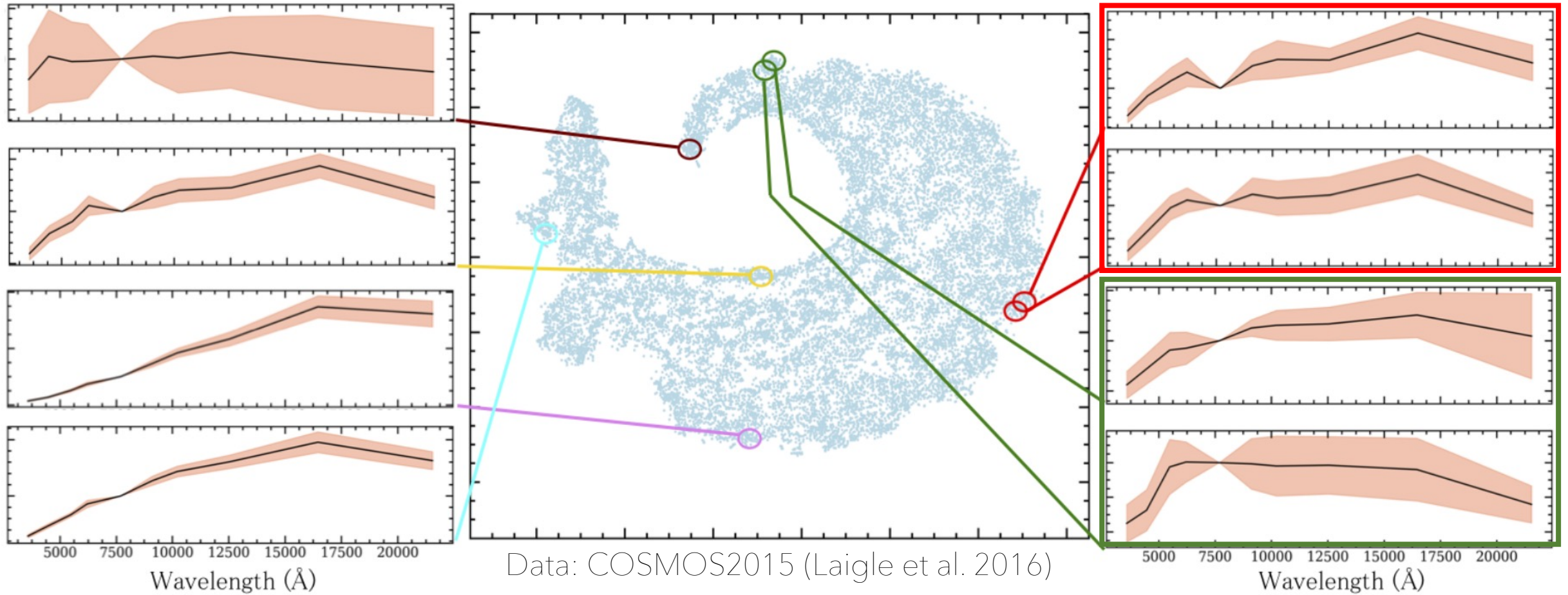
## t-SNE successfully groups galaxies by their spectral shapes!

Can **t-SNE** separate

quiescent galaxies from dusty star-forming ones?

# Application of t-SNE
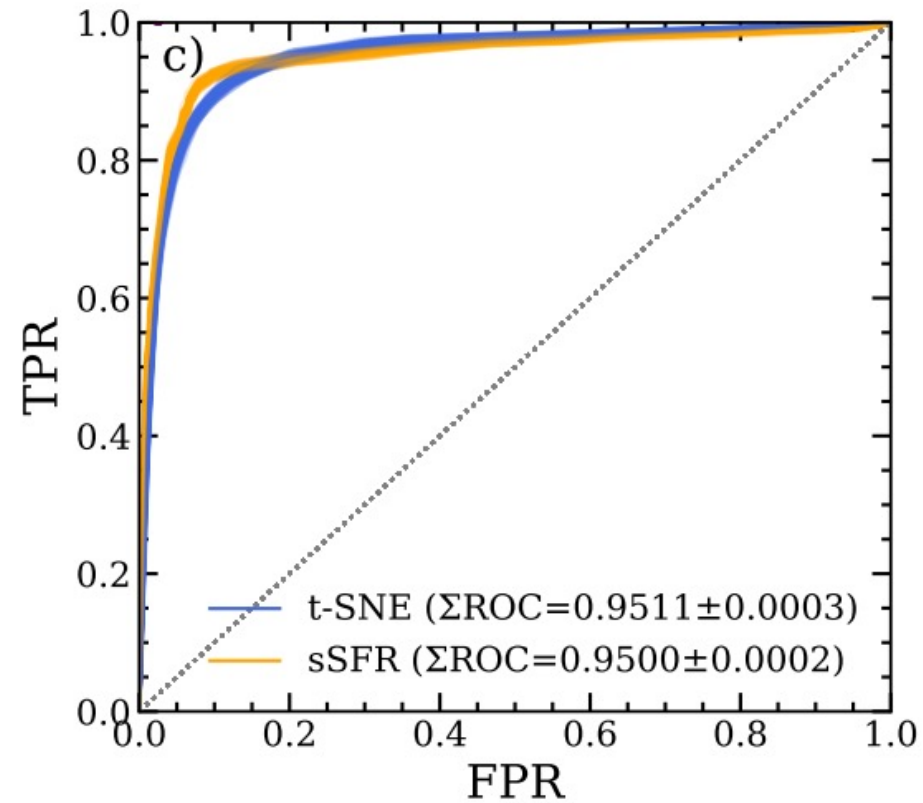
Galaxy sample at 8 Billion years ago (z~1)



50% are labelled using scarce external data (i.e. 24um)

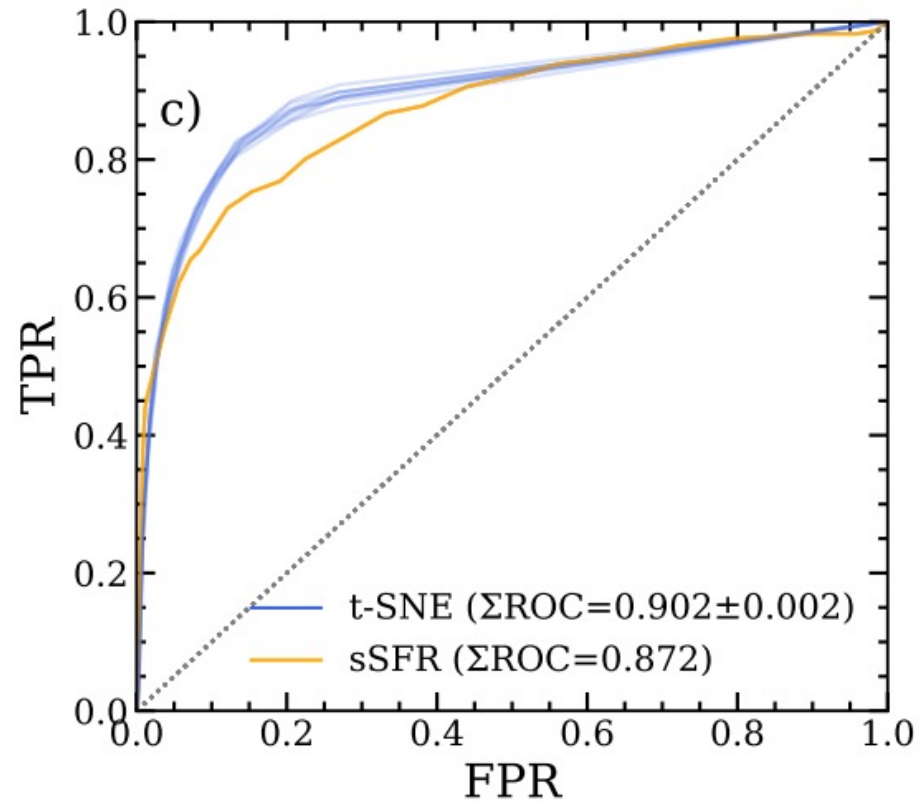The other 50% 'tests' are then classified by neighbors

# Application of t-SNE

Galaxy sample at 8 Billion years ago (z~1)
50% labelled and 50% test



t-SNE achieves better $\Sigma$ROC in 63% of trials

# Application of t-SNE

Same galaxy labelled sample at 8 Billion years ago (z~1)
**New galaxy test sample** at 10.5 Billion years ago (z~2)



c)

t-SNE ($\Sigma$ROC=0.902±0.002)
sSFR ($\Sigma$ROC=0.872)

t-SNE achieves better $\Sigma$ROC in 100% of trials

# Can t-SNE separate

## quiescent galaxies from dusty star-forming ones?

### Yes

### and better than traditional methods

### for more distant, harder to classify galaxies!

{ see Steinhardt, Weaver et al. 2019 }

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