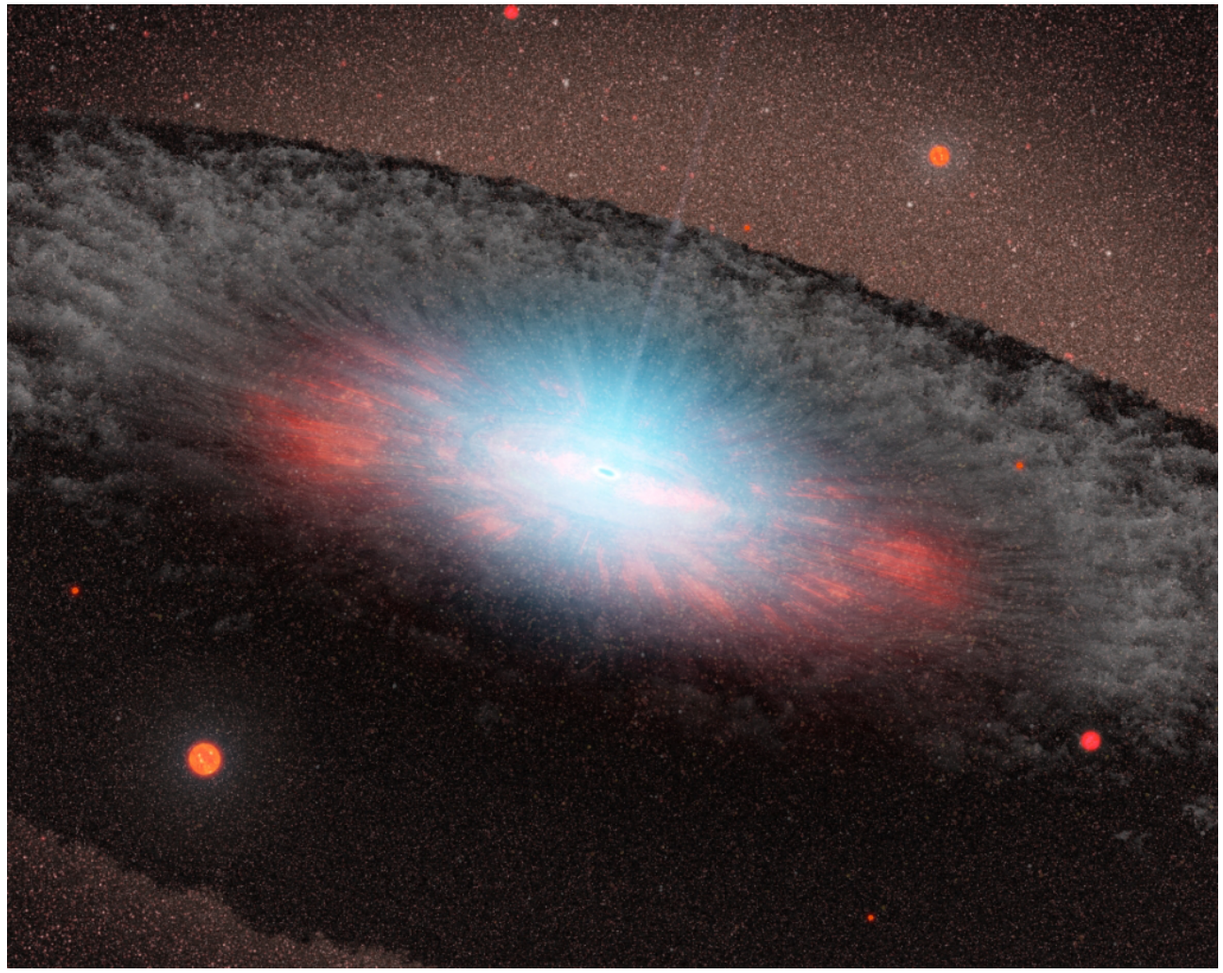
Do AGN Suppress Star Formation?

The Role of AGN in the Migration of Early-type Galaxies from the Blue Cloud to the Red Sequence



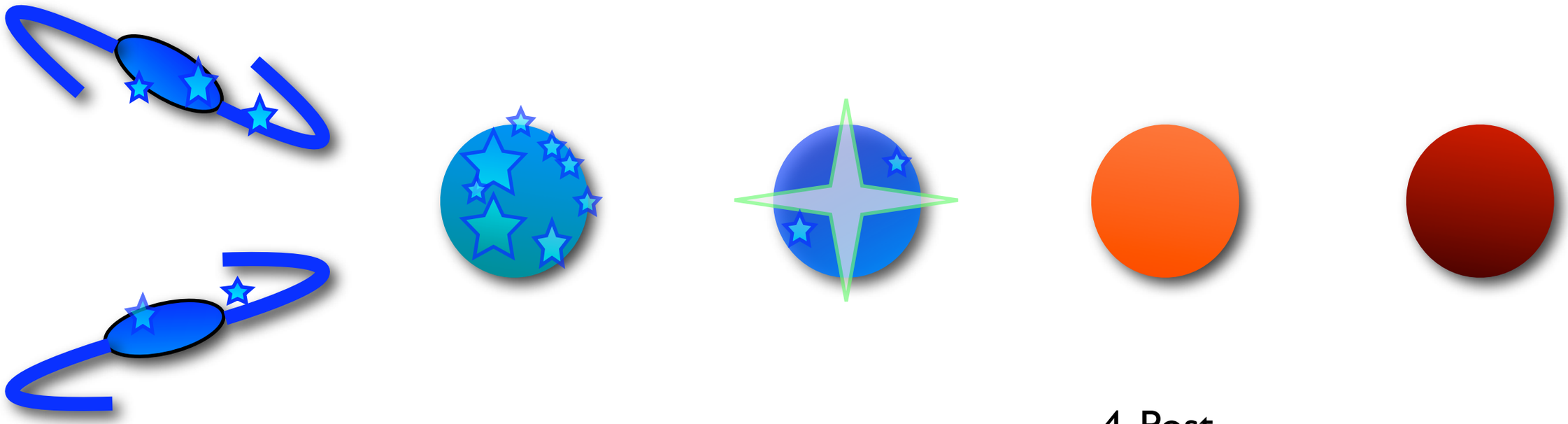
Kevin Schawinski

Yale Center for Astronomy & Astrophysics

Department of Physics

Yale University

A Sequence of Events for AGN Feedback in the formation of early-type galaxies



1. Initial approach triggered star formation

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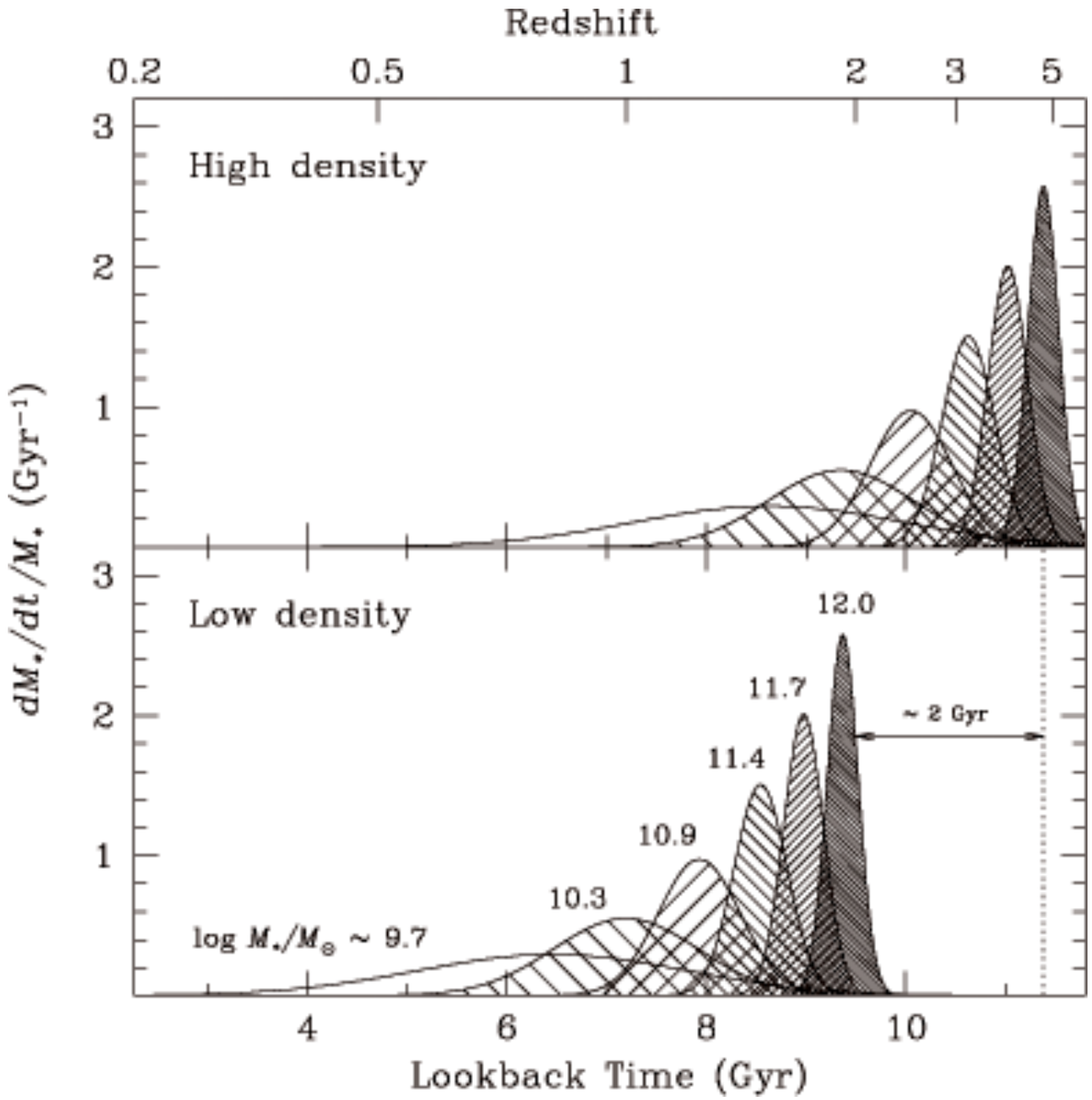
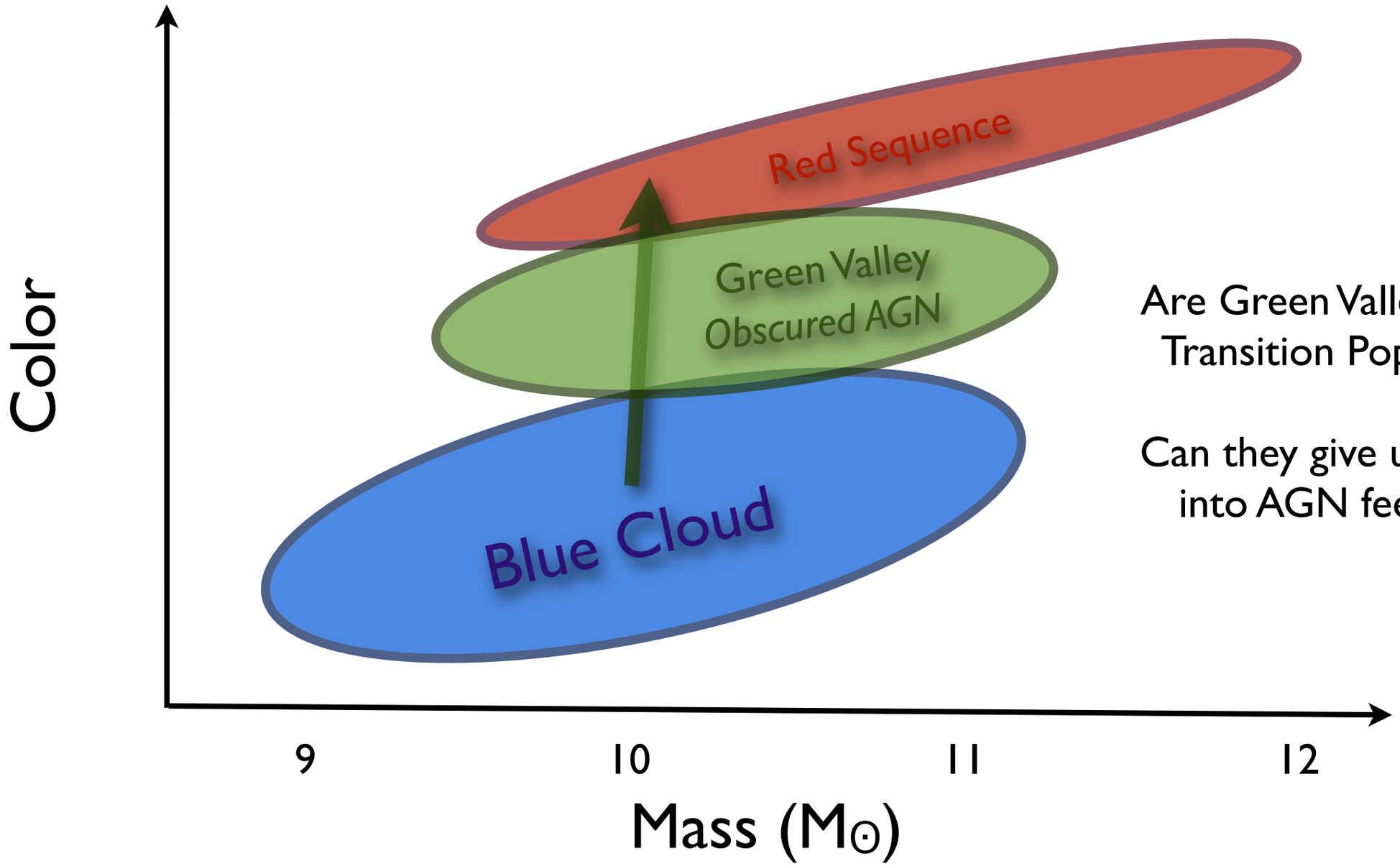
Sanders et al. (1988)

The continued anti-hierachical formation of early-type galaxies



Thomas et al. (2005)

Migration from the blue cloud to the red sequence ...via an AGN phase in the green valley?



Are Green Valley AGN a Transition Population?

Can they give us insights into AGN feedback?

What does the Green Valley really mean?

Intermediate (`green') colours do not <u>necessarily</u> imply that star formation was recently shut down

but

If star formation has recently been suppressed, then intermediate colours imply a time delay on the order of the lifetime of OB stars

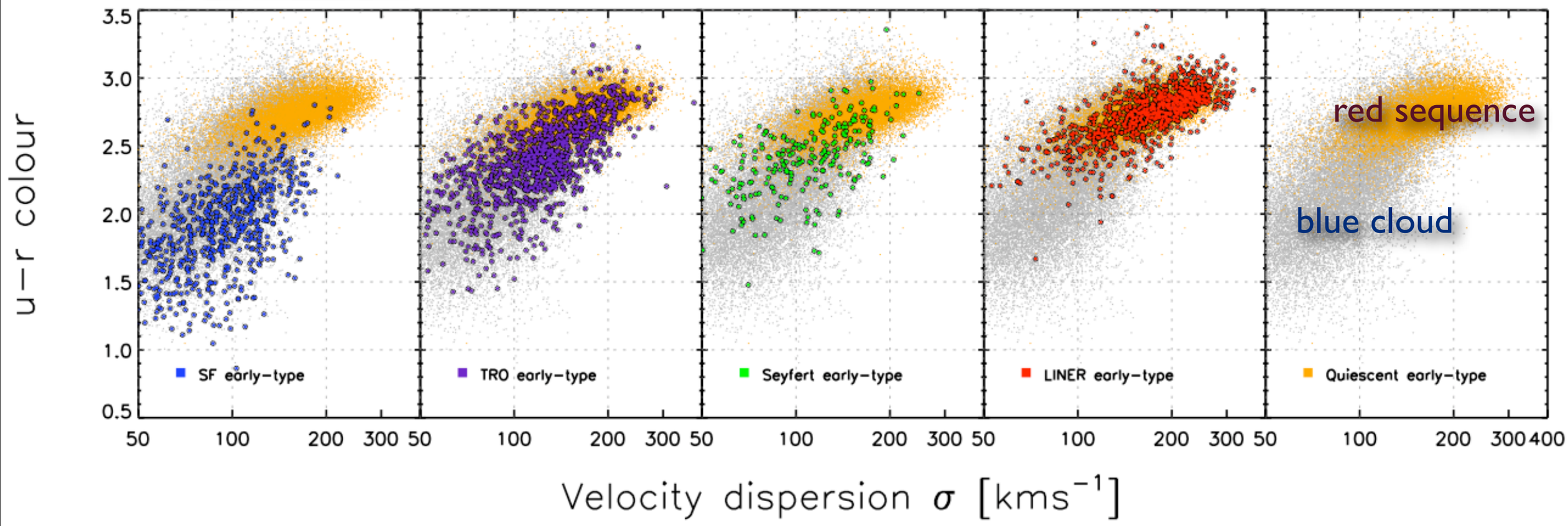
Low-mass active early-types in SDSS

Schawinski et al. 2009, MNRAS

SDSS reveals an evolutionary sequence

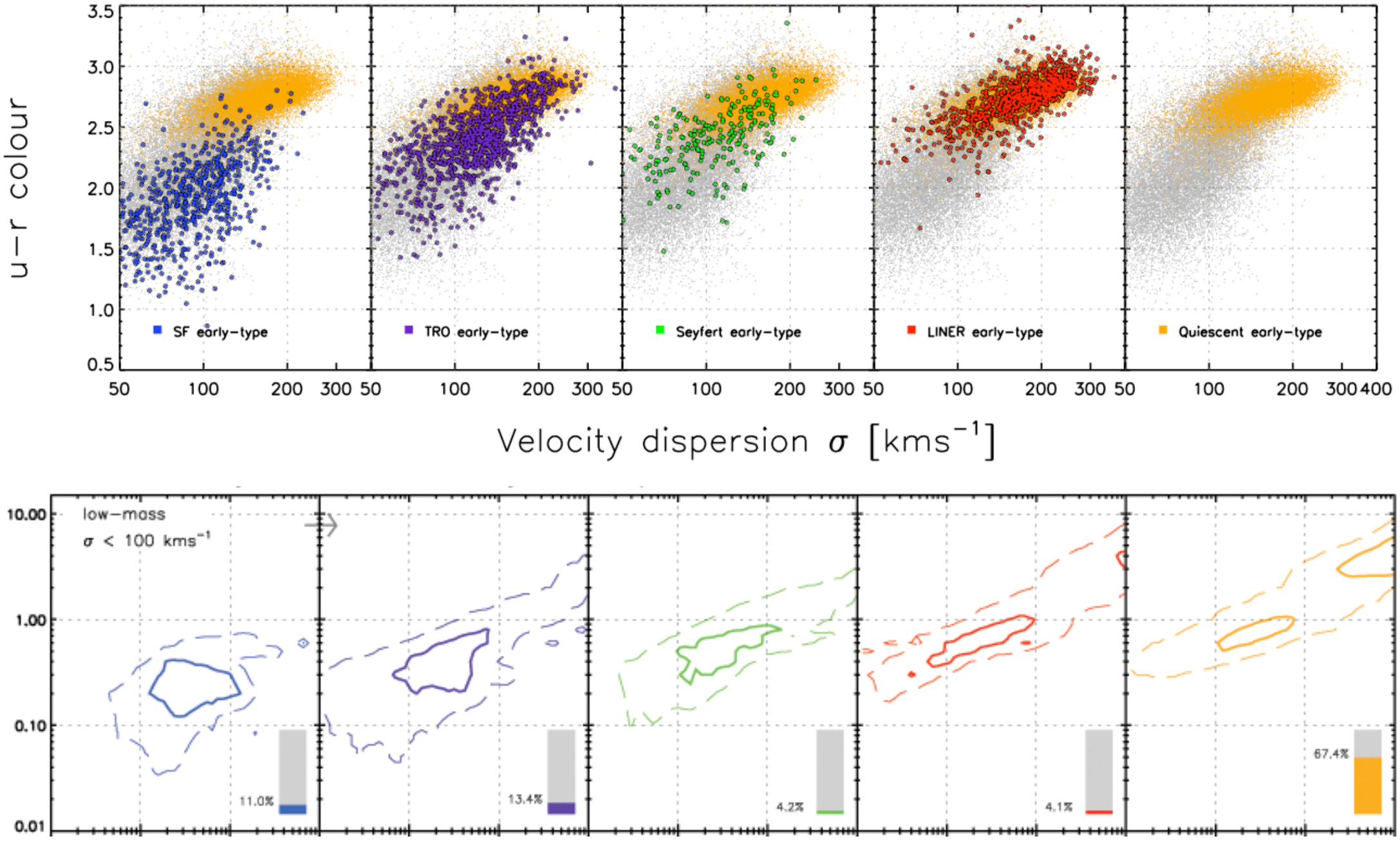
Schawinski et al. 2007, MNRAS, 382, 1415

Star Formation | AGN+SF | Seyfert AGN | LINER



Is this a genuine sequence? Are the AGN a part of it?

Recovered Star Formation Histories



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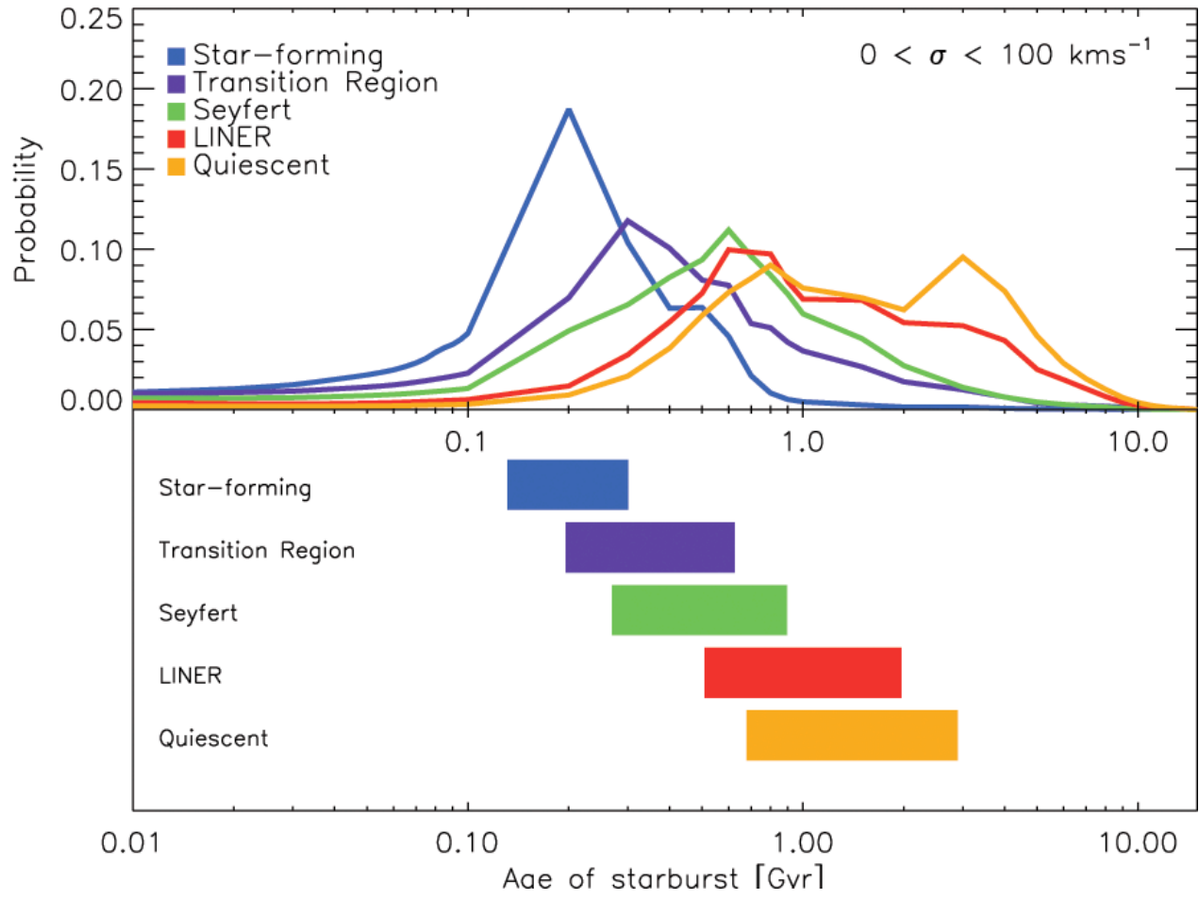
So, are we seeing AGN feedback suppressing star formation?



Transition time scales pose challenge!

Seyfert (moderate-luminosity obscured AGN) only become important ~0.5 Gyr <u>after</u> shutdown of star formation.

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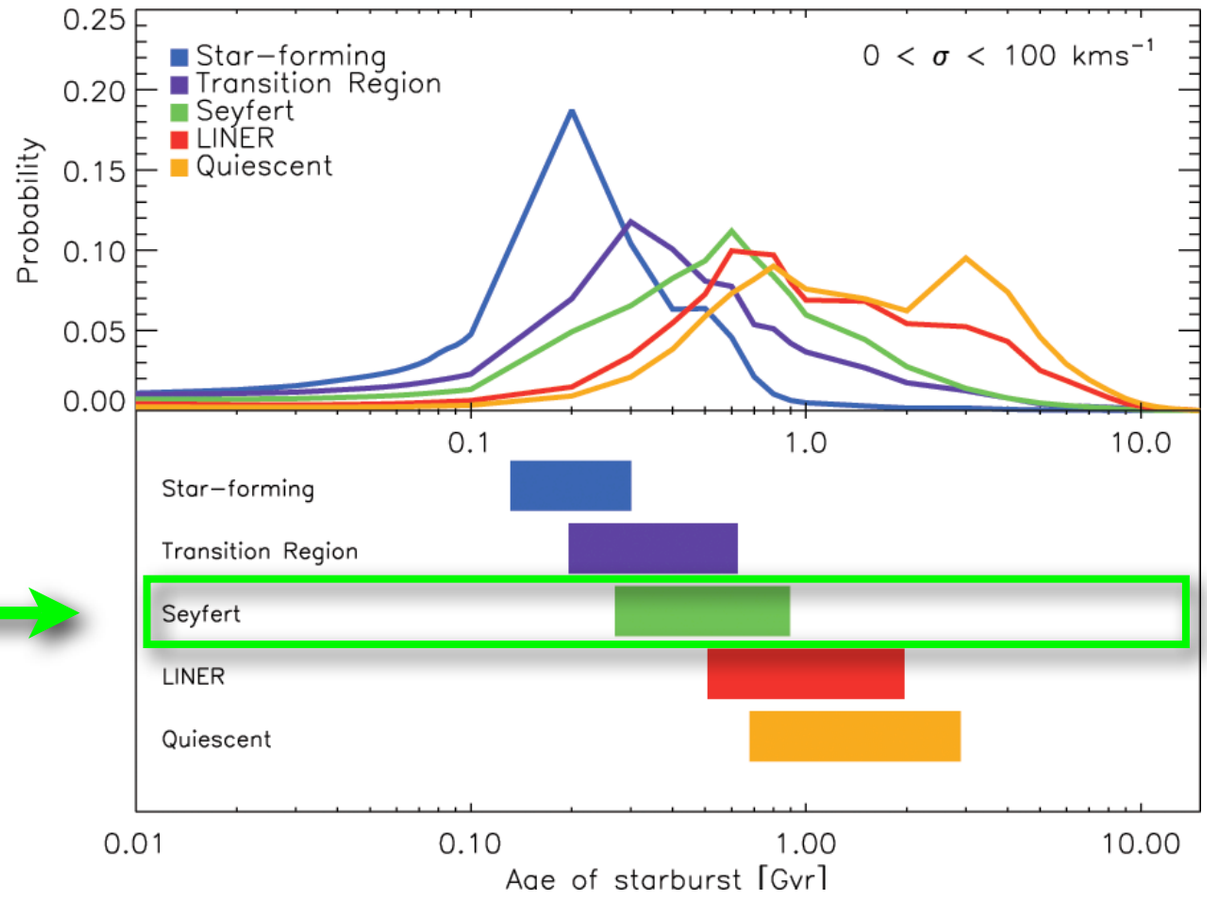

Seyfert AGN →

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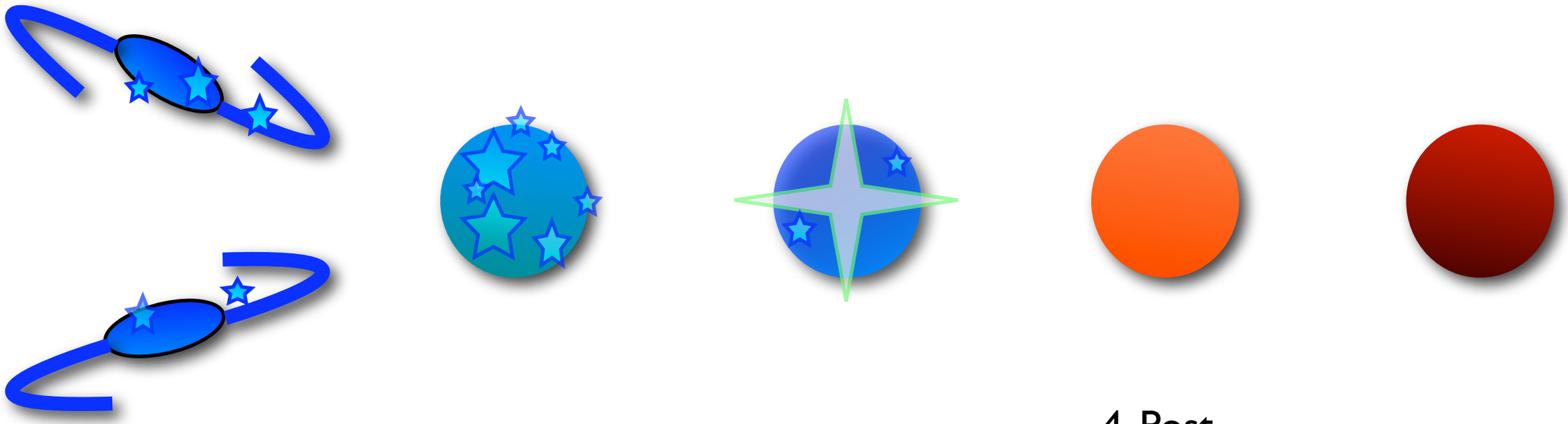
A Sequence of Events for AGN Feedback in the formation of early-type galaxies



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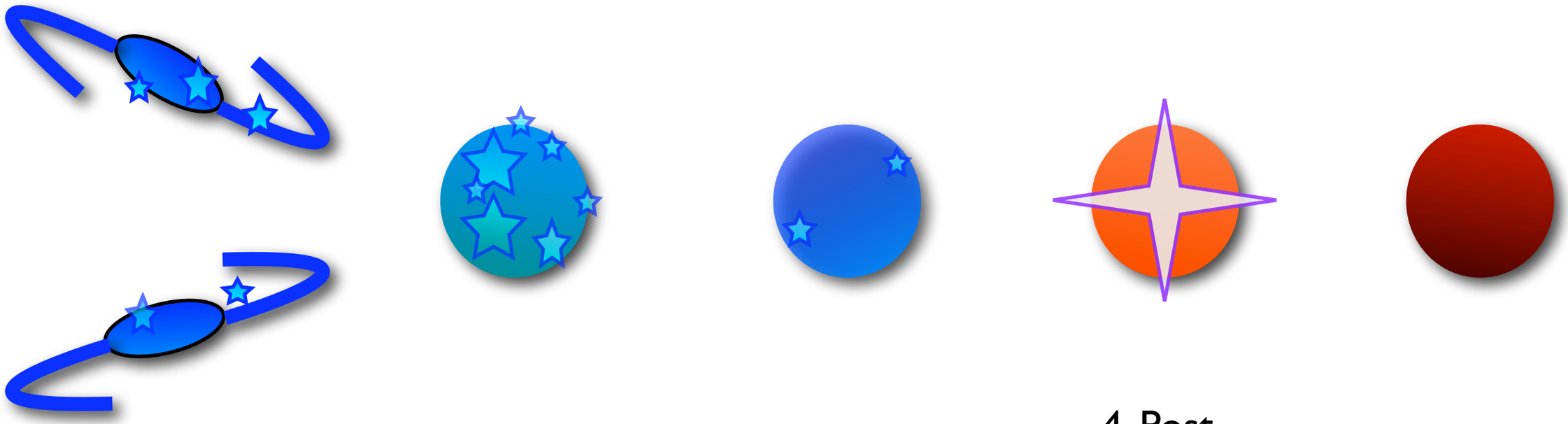

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SF shuts down

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+ AGN

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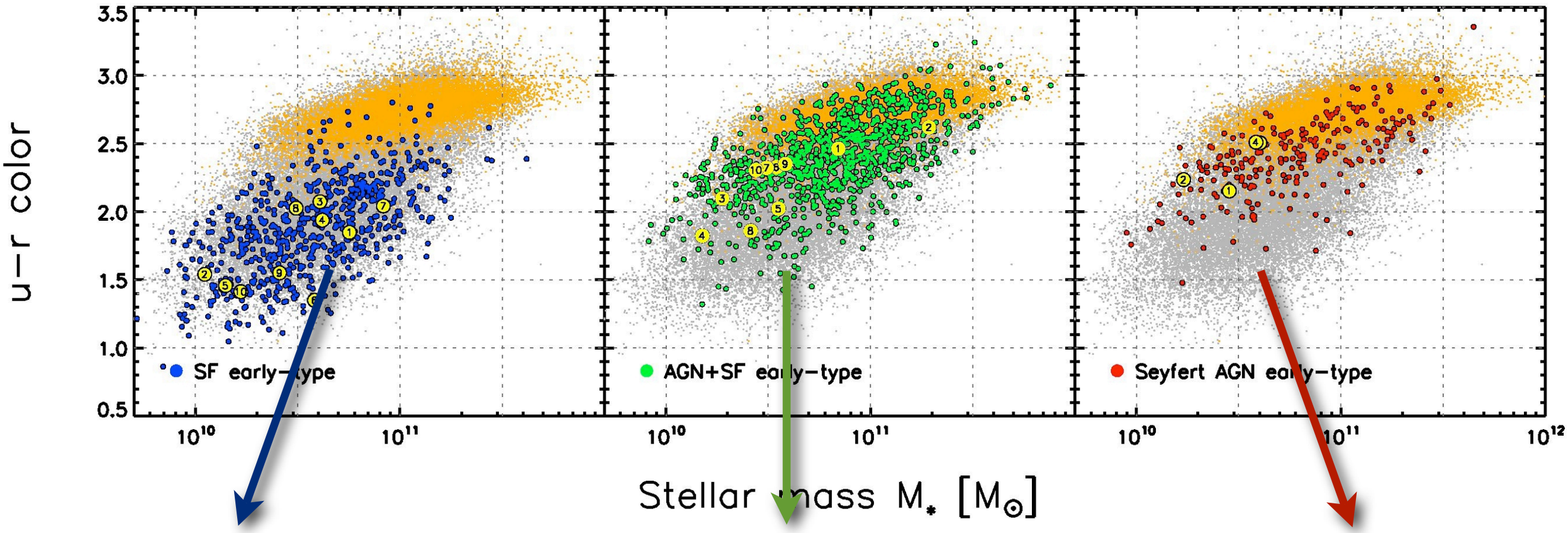
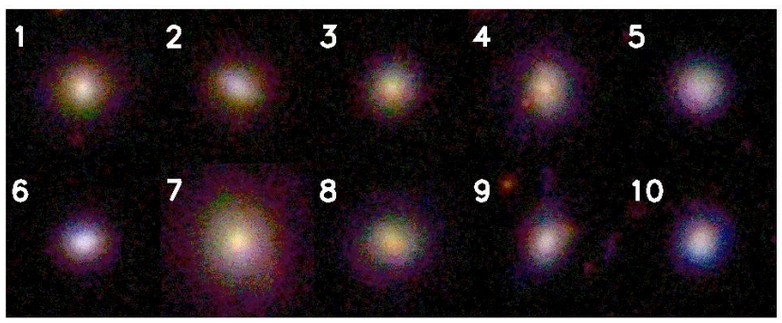
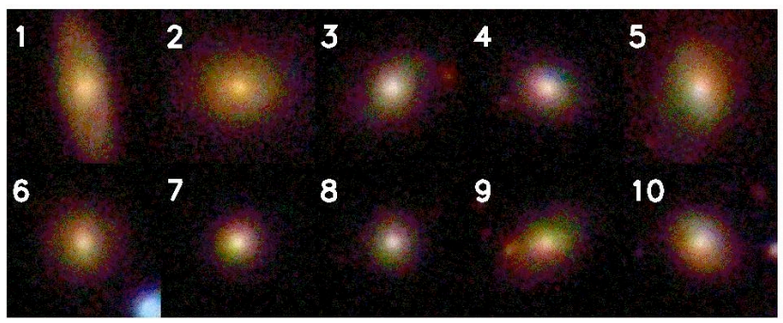
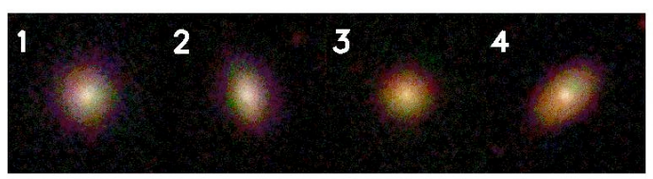
Tracing the fate of molecular gas









Starforming

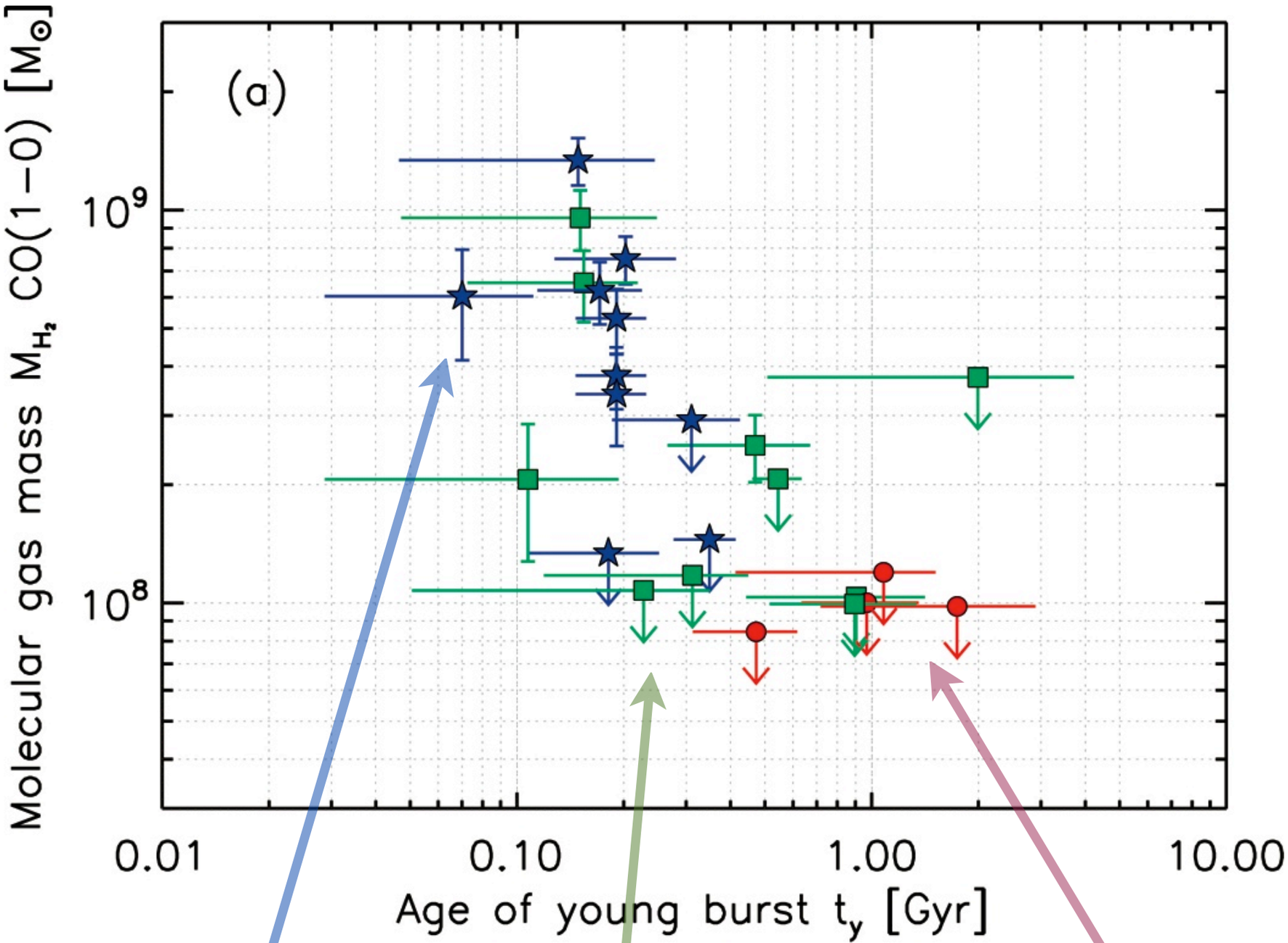
AGN+SF

Seyfert AGN

Schawinski et al. 2009, ApJ, 690, 1672

Can we rescue AGN feedback?

Schawinski et al. 2009, ApJ, 690, 1672



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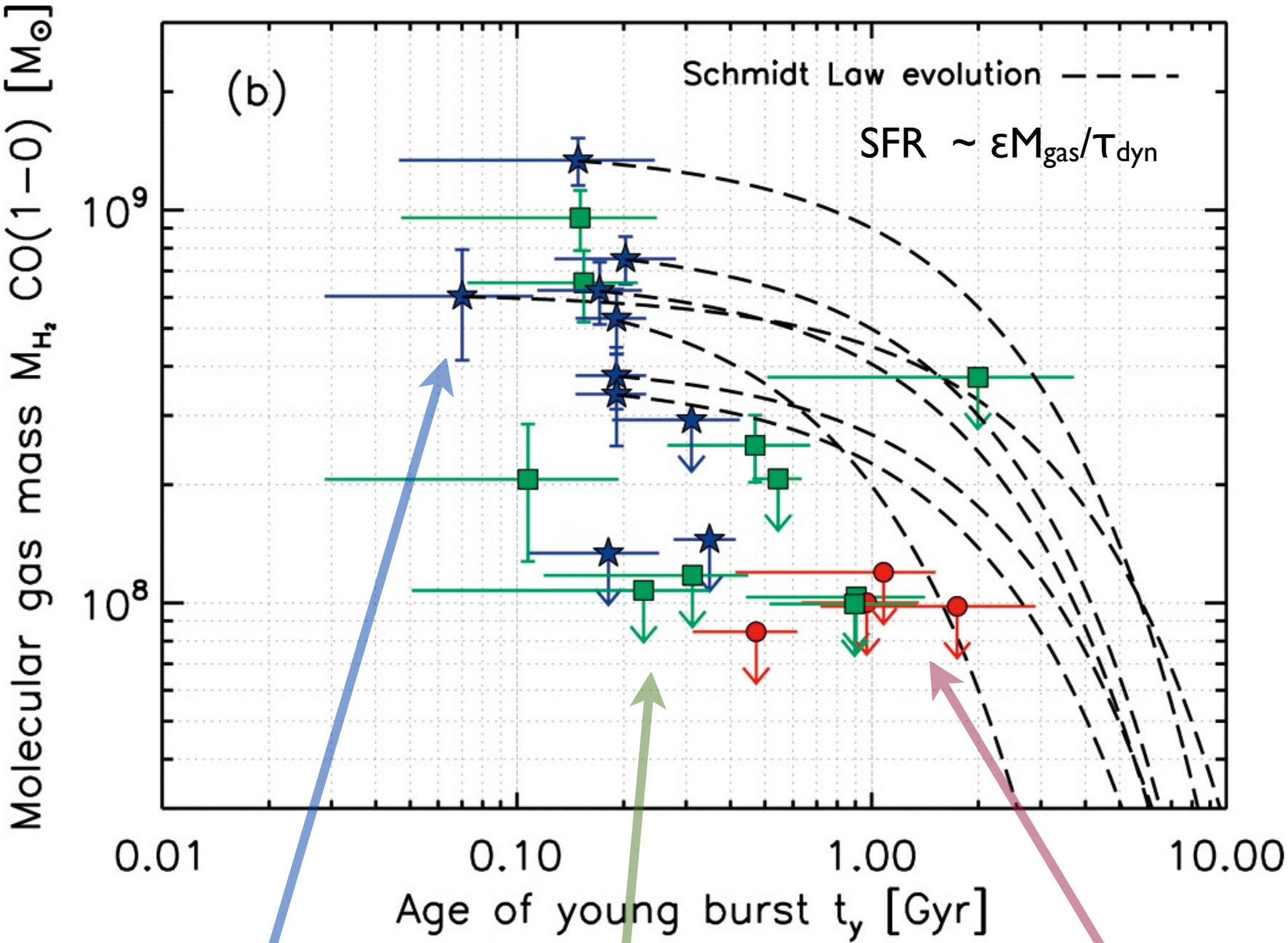

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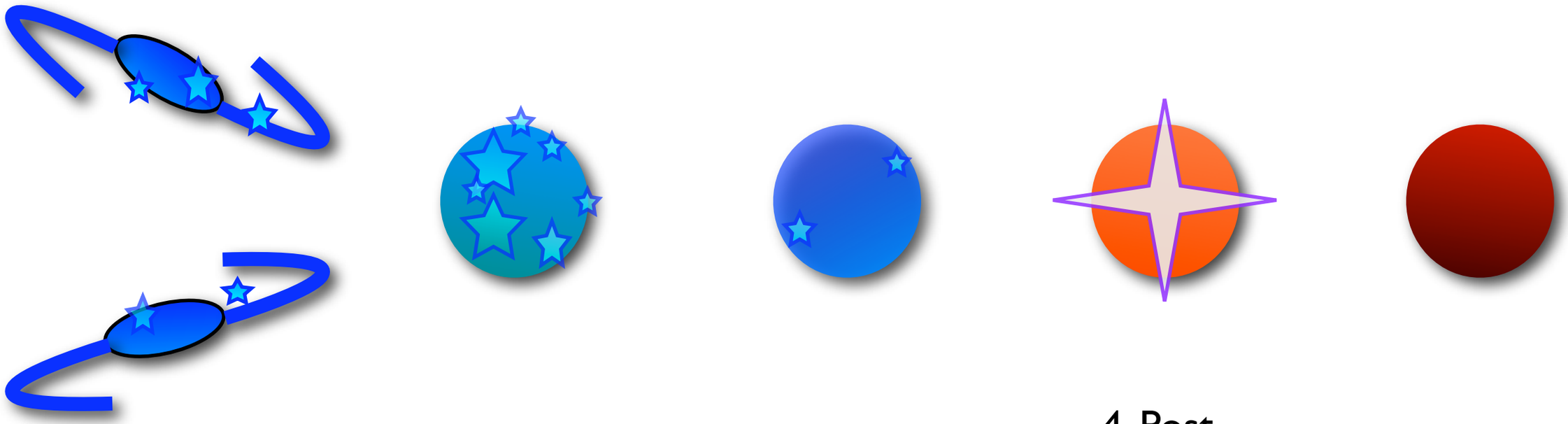
A Sequence of Events for AGN Feedback in the formation of early-type galaxies



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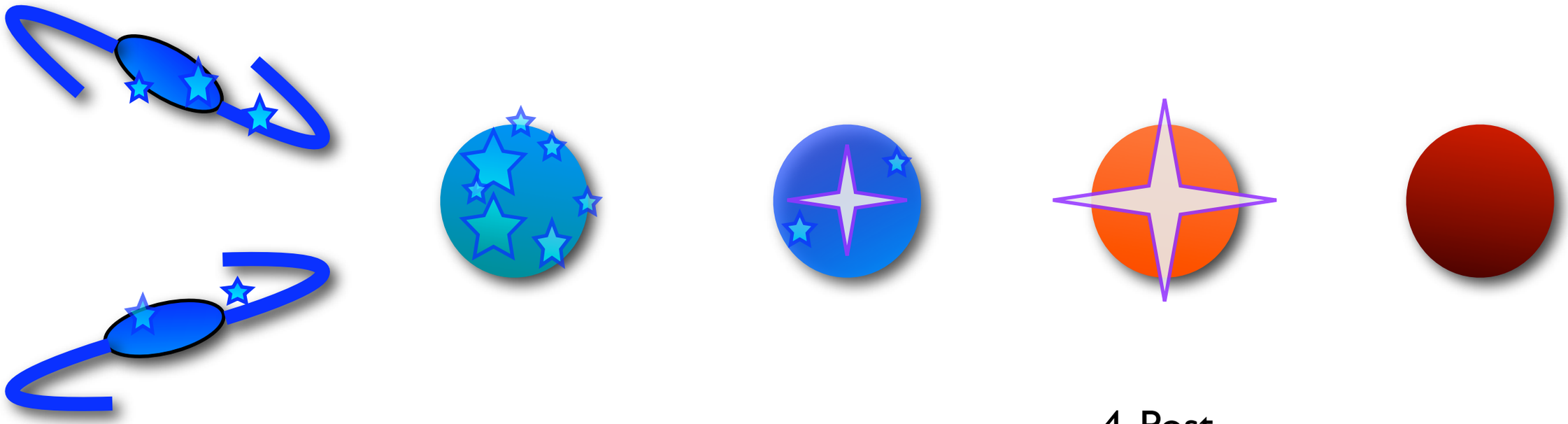

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LL AGN switches on... *Coincidence?*

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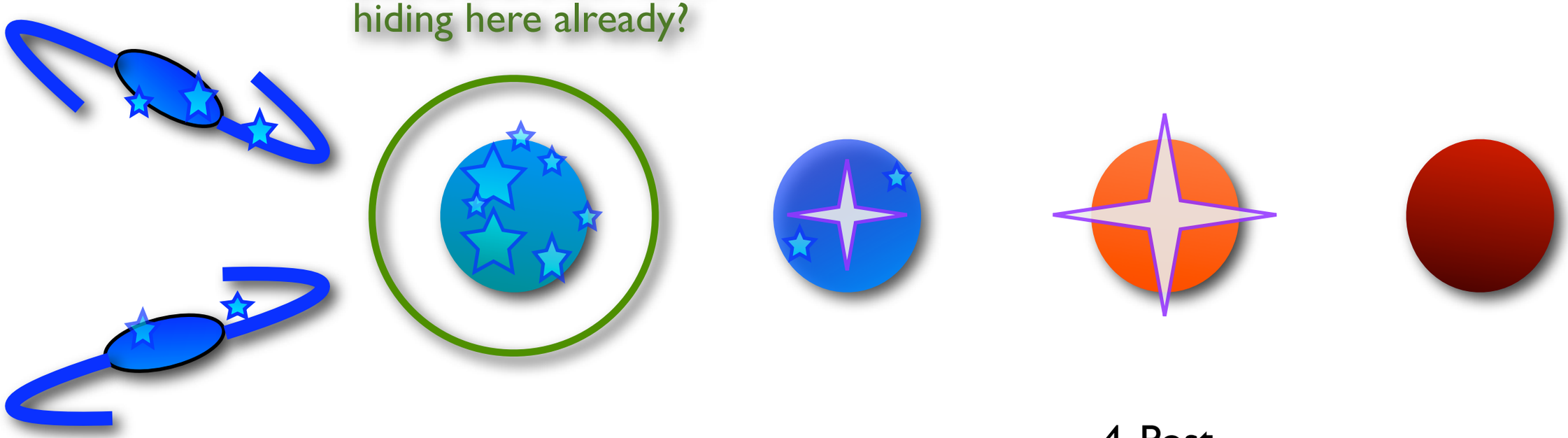
A Sequence of Events for AGN Feedback in the formation of early-type galaxies

Could there be AGN hiding here already?



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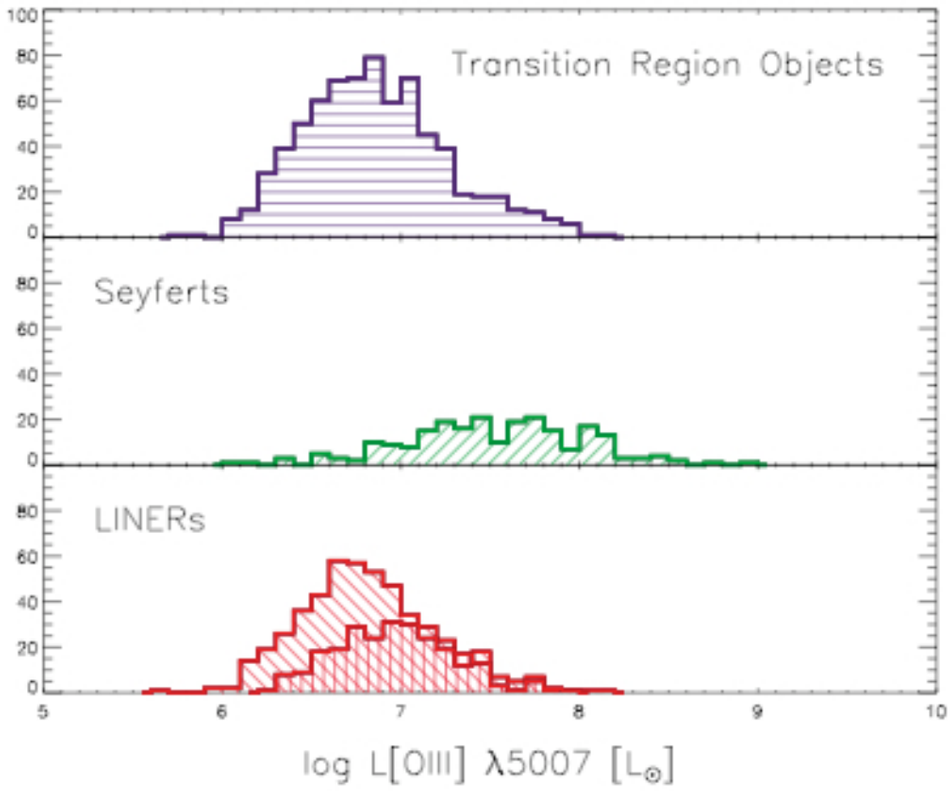
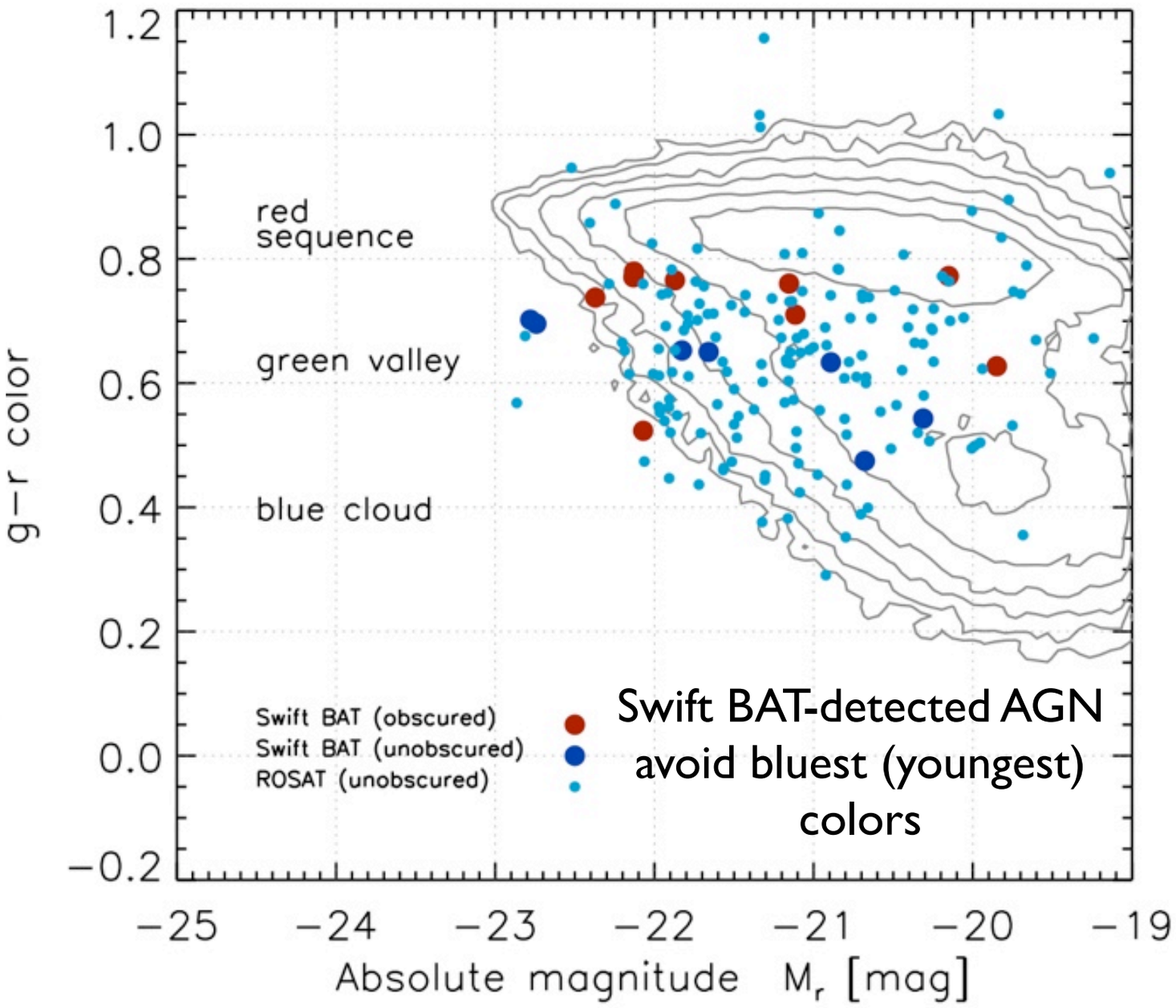
LL AGN switches on... *Coincidence?*

Unlikely!



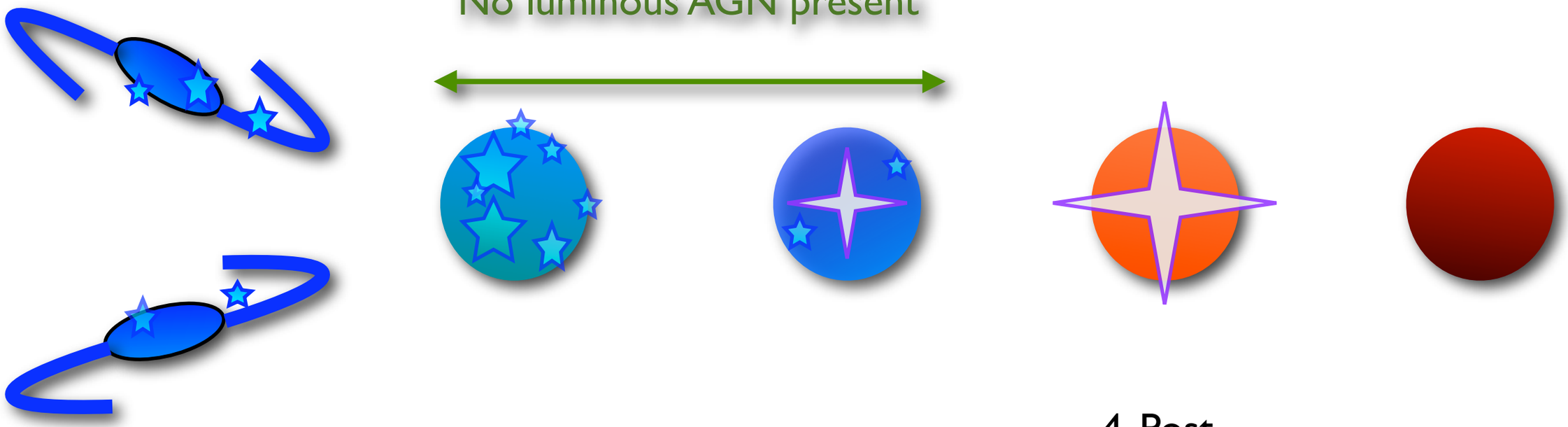
L[OIII] increases w/ time



Swift BAT-detected AGN avoid bluest (youngest) colors

Schawinski et al. 2009, ApJ, 692, L16

A Sequence of Events for AGN Feedback in the formation of early-type galaxies



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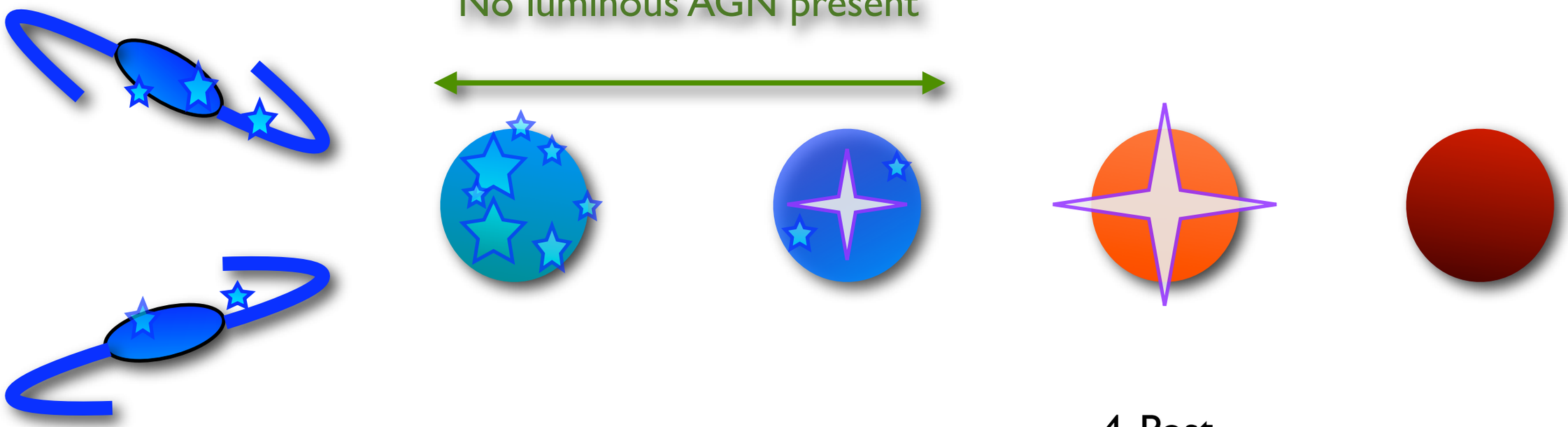
A Sequence of Events for AGN Feedback in the formation of early-type galaxies

What about the trigger?

No luminous AGN present



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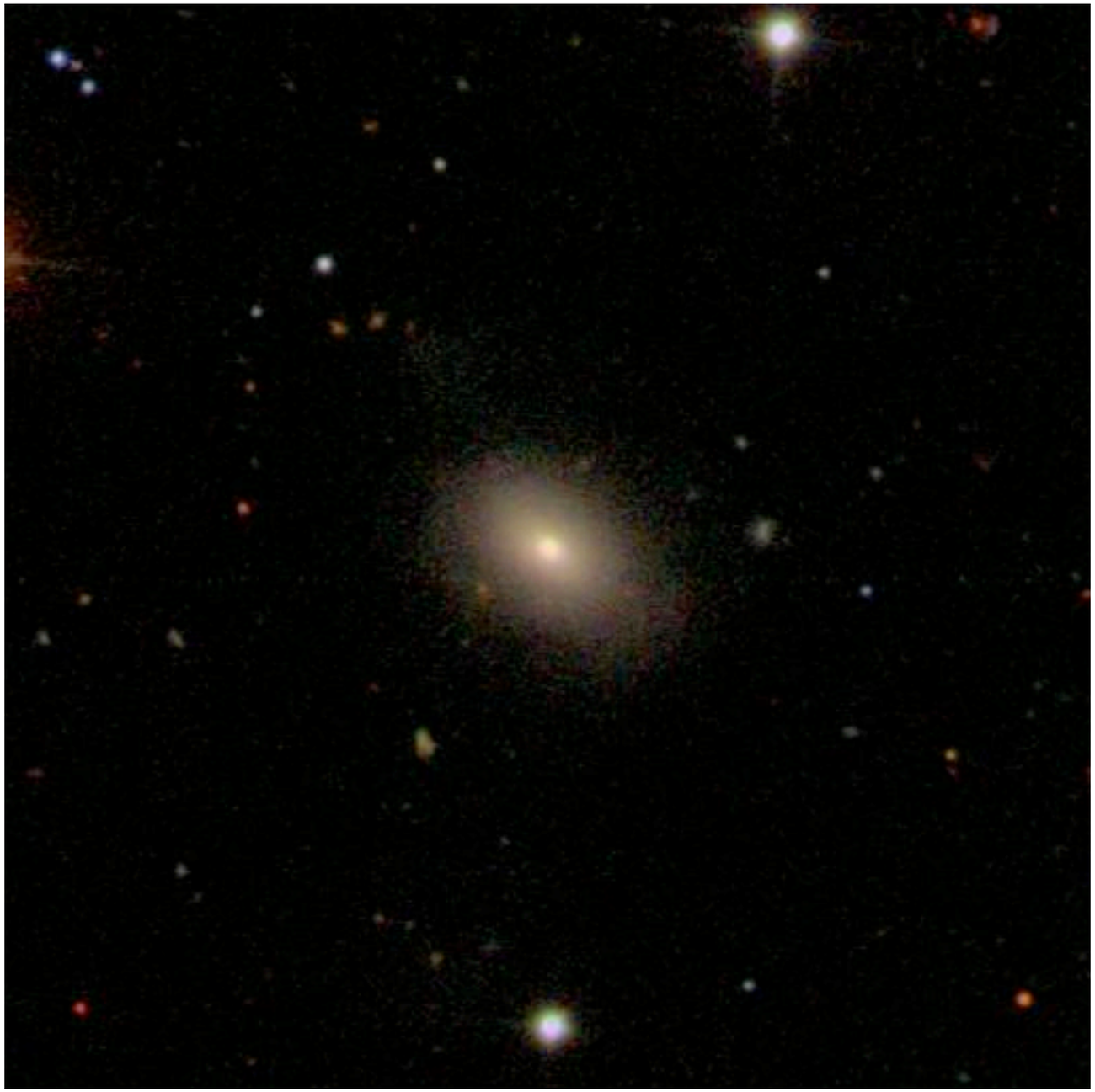
...Major Mergers might be involved?



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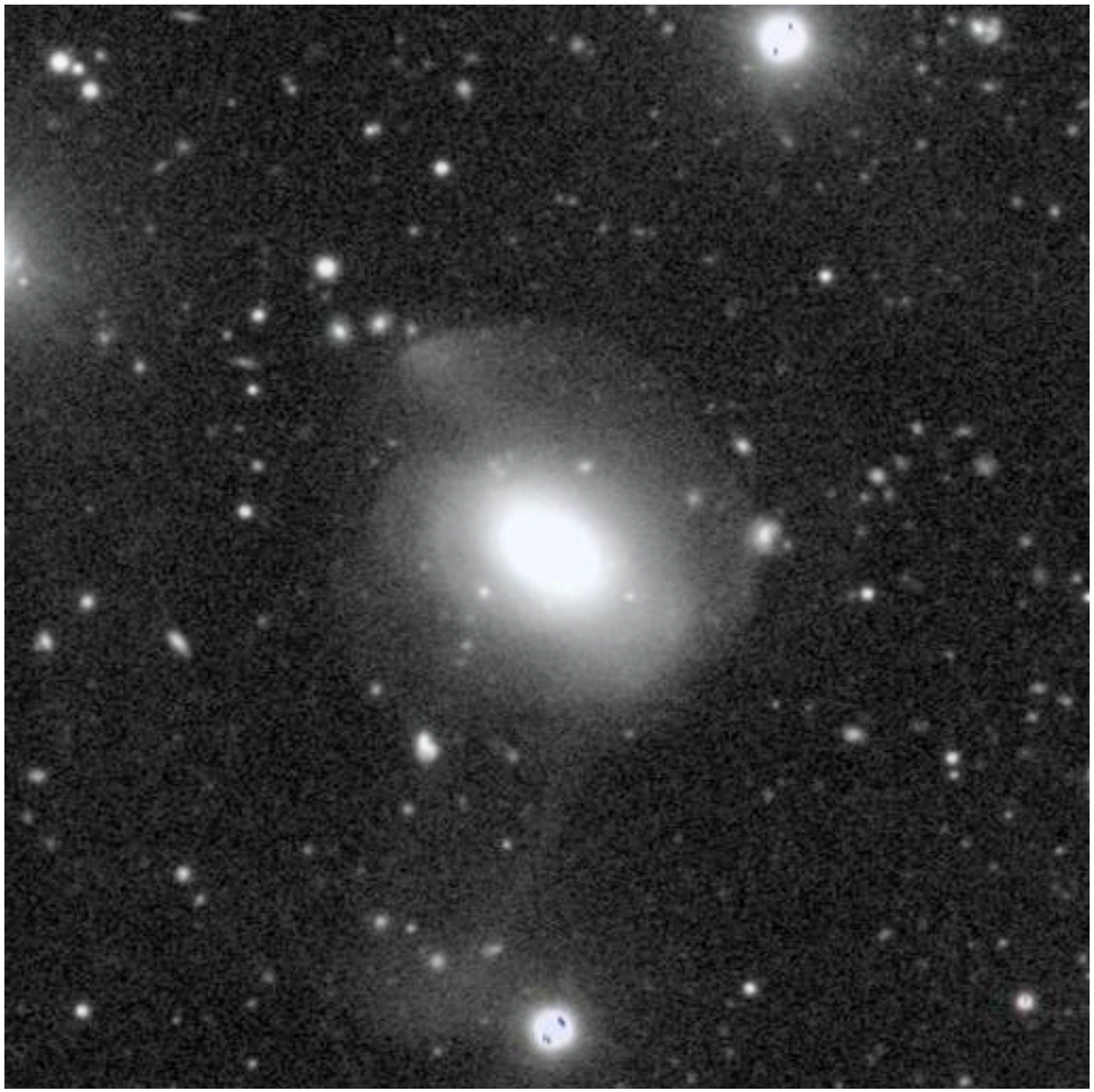


Summary

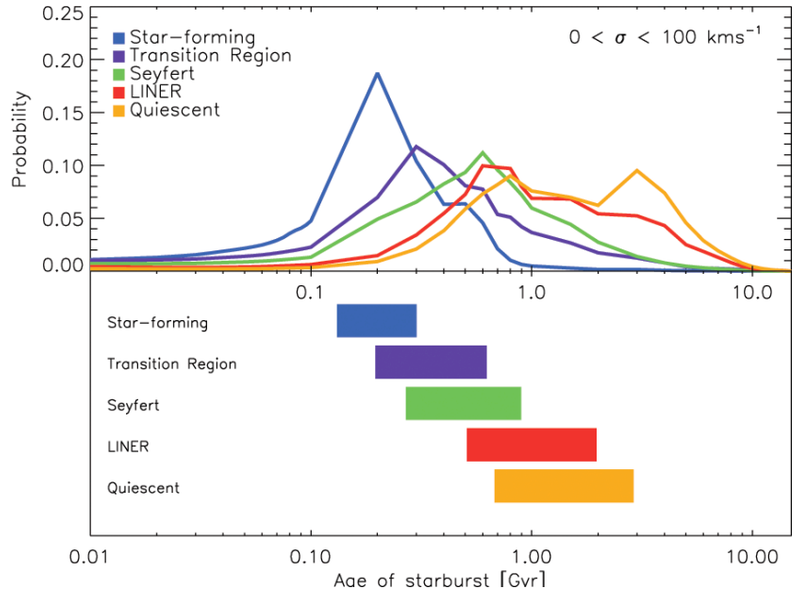
Early-type galaxies **continue to build** or return to the low-mass end of the red sequence.

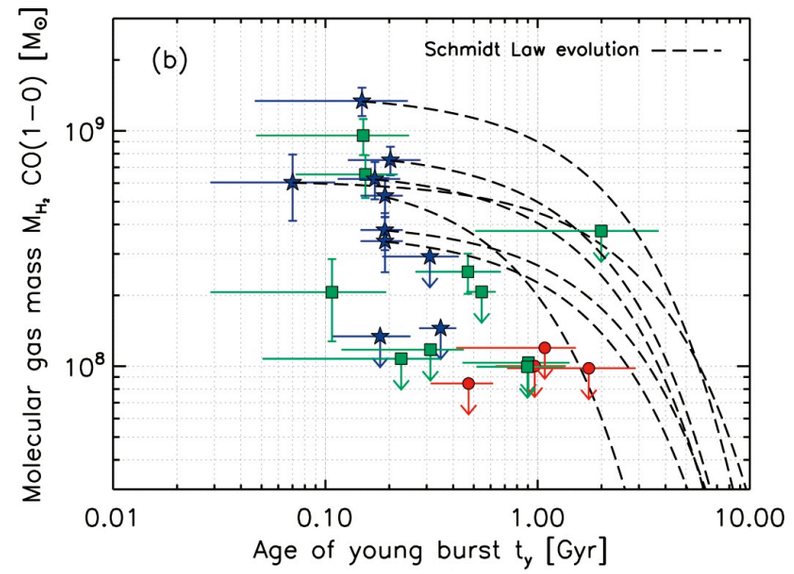
Time sequence of events includes a slow rise of AGN peaking in the green valley **~0.5 Gyr after shutdown**.

Molecular gas disappears **extremely rapidly** ~200 Myr after start of current starburst and **coincides with low-L AGN phase**,

High-L AGN phase **too late** for suppression and cannot be responsible for shutdown of SF.

<u>Time scales are a major puzzle!</u>





References:

Schawinski et al. 2007, MNRAS, 282, 1415, arxiv:0709.3015

Schawinski et al.. 2009a, ApJ, 690, 1672, arxiv:0809.1096

Schawinski et al. 2009b, ApJ, 692, L19, arxiv:0901:1663

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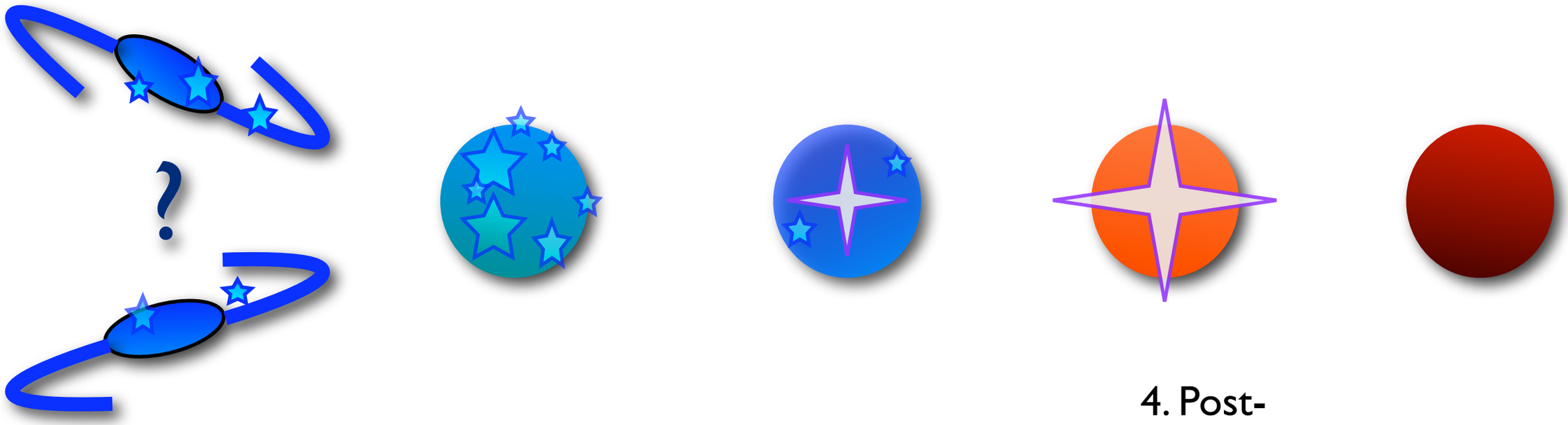

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3. LL AGN switches on

-

at the same time SF is shut down as H_2 reservoir is destroyed

4. Post-starburst galaxy hosting Seyfert AGN

5. Passive early-type

Thank you!