Quasars and Galaxy Formation

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Outline

- Star Formation vs. BH Formation
- Early BH Formation
- SMBH Results
- Consequences
Which Came First?

- Stars or BH’s?
- Generally assumed to be stars in 1997
- Let’s assume BH’s form first
Formation and Early Growth of SMBH

- Early BH: $M_{bh} > 10^6 \beta M_\odot$
- Formation Efficiency: $f \gtrsim 10^{-5} \beta$

Where $\beta \sim 1$

- Mergers
SMBH Results

\[ M_{bh} = 2 \times 10^{-3} M_{sph} \]

\[ M_{bh} > \alpha \frac{\sigma^5 \kappa}{G^2 c} = 8 \times 10^8 \gamma \left( \frac{\sigma}{500 \text{ km s}^{-1}} \right)^5 M_\odot \]
Consequences

• SMBH could eject all gas from the galaxy
• BH Mass stabilizes from mergers
SMBH and Galaxy Formation

- Dwarf Galaxy formation suppression
- High Star formation rates near SMBH
- Star Formation stimulated by SMBH
Conclusions

- $M_{bh}$ to $M_{sph}$
- Self Regulation of BH growth
- SMBH Stimulating galaxy formation