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

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

$$M_{bh} > \alpha \frac{\sigma^5 \kappa}{G^2 c} = 8 \times 10^8 \gamma (\frac{\sigma}{500 kms^{-1}})^5 M_\odot$$

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