

AGN Feedback and Environmental Influences

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Outline

- 1 Introduction
- 2 Methodology
- 3 Self-Regulated Bubble Feedback

Layout

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Motivation

- BH mass \Leftrightarrow stellar properties
- Formation and evolution of galaxies tied to their BH
- And vice versa!

Interaction Channels

- Quasar-like Feedback
 - Mergers of gas-rich galaxies funnel gas to central regions
 - Increases accretion rate of embedded BH
 - Accretion luminosity fuels quasar
 - Quasar produces high-velocity winds that affect host galaxy
- Mechanical Bubble Feedback
 - X-ray cavities found in Elliptical galaxies galaxy clusters
 - Inflated by relativistic jets from BH
 - Leading candidate for resolving the “cooling flow” problem

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Methodology Overview

- Numerical simulation
- High accretion rates \Rightarrow quasar-like feedback
- Low accretion rates \Rightarrow mechanical bubble feedback
- Consider single galaxies through galaxy clusters

Black Hole Formation and Growth

- Assume that “low-mass” seed BHs are produced in all halos of sufficient mass
 - $M_{BH} = 10^5 h^{-1} M_{\odot}$, for all halos above $10^{10} h^{-1} M_{\odot}$
- Due to resolution issues, $M_{BH} \neq M_{dyn}$
- $\dot{M} \propto M_{BH}^2$ (Bondi-Hoyle-Littleton formula)

Black Hole Feedback

- The transition from **quasar heating** to **mechanical bubble** feedback is set by $\dot{M}_{BH}/\dot{M}_{Edd} = 10^{-2}$
- For high accretion, a small fraction of the bolometric luminosity is coupled to the gas
- For low accretion, hot bubbles are injected into the gas

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