Can we distinguish formation models of a super-massive black-hole?

Hisaaki Shinkai (Osaka Institute of Technology) Toshikazu Ebisuzaki (RIKEN) & Nobuyuki Kanda (Osaka City Univ.)

Outline & Summary

The second generation of detectors, such as KAGRA, advanced LIGO, advanced VIRGO, and future planned Einstein Telescope have enough sensitivity over 10 Hz, which enable us to detect the ringdown gravitational wave from a BH of the mass less than 2000 M_solar. We discuss how can we distinguish models for forming a super-massive black-hole (SMBH) via mergers of intermediatemass black-holes (**IMBHs**) by accumulating event data. We assume two different merging histories; hierarchical growth and monopolistic growth, and compare their event rates. The former model assumes accumulations of coalesces of equal-mass binaries, while the latter

assumes only one BH grows by sweeping others.



The observable distances highly depend on the unknown BH spin parameter, but we show event rates

will differ by models as a function of frequency, corresponding to mass distribution function of each model.

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IMBH-IMBH inspiral at Space Interferometers



FIG. 1.—Expected gravitational radiation amplitude from merging IMBHs of (a) the hierarchical growth model and (b) the monopolistic growth model. We plot both the inspiral phase (f_{insp} , h_{insp} ; eqs. [2] and [3]) and the ringdown phase (f_{ONM} , h_{coal} ; eqs. [4] and [6]) for various mass combinations. The open and filled circles and squares in the inspiral phase are of $a = 50R_{\text{grav}}$, $10R_{\text{grav}}$, and $5R_{\text{grav}}$. The final burst frequency, f_{QNM} , depends on the efficiency, ϵ , which we fix at $\epsilon \simeq 10^{-2}$ for the plots. The lines represent the sensitivities of future detectors (*LISA*, DECIGO, LIGO 2, and LCGT), taken from Fig. 1 in Seto et al. (2001). The data are evaluated at the distance R = 4 Gpc



IMBH ringdown at Ground Interferometers



Fig. 2.—Event numbers of mergers starting from 1000 IMBHs with masses of $10^3 M_{\odot}$. The vertical axis is the event rate $\nu(yr^{-1})$ from eqs. (12), and (14). The horizontal axis is for the mass of the postmerger BH, M_T , which is also interpreted in the final gravitational radiation frequency f_{ONM} . Panels (a) and (b) are for the hierarchical growth model and for the monopolistic growth model, respectively. Both plots are for a homogeneous distribution model in which we just multiply by 3 each event rate for the thin-shell galaxy distribution model. If a SMBH expands hierarchically, then the bursts of gravitational radiation appear in the higher frequency region. In the monopolistic model, the bursts appear in lower frequency region. We fix the increasing-mass rate, α , at unity for the plots.



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(unknown factor)





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