

[HOME](#) > [セミナー・研究会 Seminar & Workshop](#) > [Seminar](#) > Binary black hole remnants of First stars for the gravitational wave source (in English)

[お知らせ](#)

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[リンク](#)



HIGH ENERGY ACCELERATOR RESEARCH ORGANIZATION  
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## Seminar

# Binary black hole remnants of First stars for the gravitational wave source (in English)

SPEAKER: Dr. Tomoya Kinugawa (ICRR, The University of Tokyo)

DATE : July 21 (Thur.) 13:00 - 14:00

PLACE : Kenkyu Honkan 1F Meeting Room 1

Using our population synthesis code, we found that the typical chirp mass of binary black holes (BH-BHs) whose origin is the first star (Pop III) is  $\sim 30 M_{\text{sun}}$  with the total mass of  $\sim 60 M_{\text{sun}}$  so that the inspiral chirp signal as well as quasi normal mode (QNM) of the merging black hole are interesting targets of LIGO, VIRGO and KAGRA (Kinugawa et al. 2014 and 2016). The detection rate of the coalescing Pop III BH-BHs is  $\sim 180$  events/yr ( $\text{SFR}_p / (10^{-2.5} M_{\text{sun}} / \text{yr} / \text{Mpc}^3) * ([f_b / (1 + f_b)] / 0.33) * \text{Err}_{\text{sys}}$  in our standard model where  $\text{SFR}_p$ ,  $f_b$  and  $\text{Err}_{\text{sys}}$  are the peak value of the Pop III star formation rate, the binary fraction and the systematic error with  $\text{Err}_{\text{sys}}=1$  for our standard model, respectively. Furthermore, We found that the chirp mass has a peak at  $\sim 30 M_{\text{sun}}$  in most of parameters and distribution functions (Kinugawa et al. 2016). This result predicted the gravitational wave events like GW150914 and LIGO paper said 'recently predicted BBH total masses agree astonishingly well with GW150914 and can have sufficiently long merger times to occur in the nearby universe (Kinugawa et al. 2014)' (Abbot et al. ApJL 818,22 (2016)). Nakano, Tanaka & Nakamura 2015 show that if S/N of QNM is larger than 35, we can confirm or refute the General Relativity more than 5 sigma level. In our standard model, the detection rate of Pop III BH-BHs whose S/N is larger than 35 is 3.2 events/yr ( $\text{SFR}_p / (10^{-2.5} M_{\text{sun}} / \text{yr} / \text{Mpc}^3) * ([f_b / (1 + f_b)] / 0.33) * \text{Err}_{\text{sys}}$ ). Thus, there is a good chance to check whether GR is correct or not in the strong gravity region and to check indirectly the existence of Pop III massive stars by gravitational wave.

[ページトップへ](#) ▲

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