



ICTP-AP International Centre for Theoretical Physics Asia-Pacific 国际理论物理中心-亚太地区

Axion Star Detection with Gravitational Waves

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Macroscopic ECO detectable with GW (LIGO, Taiji/Tianqin/LISA, PTA, ...)

Non-Topological Solitons

Macroscopic Bose-Einstein condensate made of ultralight particles (DM)

Lee,Pang, Phys.Rept (1992)

Liebling, Palenzuela, Living Rev.Rel [1202.5809]





Properties (dilute, dense, stability, ...)

Sikivie, Yang, PRL [0901.1106] Braaten, Mohapatra, Zhang, PRL [1512.00108] Hong Zhang, Symmetry [1810.11473] Visinelli, Baum, Redondo, Freese, Wilczek, PLB [1710.08910]

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Formation

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Hogan, Rees, PLB, 1988 Kolb, Tkachev, PRL [9303313] Tkachev, PLB, 1990

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Detection

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Croon, McKeen, Raj, Wang, PRD [2007.12697] Buckley, Dev, Ferrer, Huang, PRD [2004.06486] Amin, Long, Mou, Saffin, JHEP [2103.12082] Qiu, Gao, Tian, ... [2404.18099] (Yu Gao's talk)

Exotic Compact Objects

Cardoso, Pani, Nature Astron [1709.01525]





Subsolar PBH Searches

Rising interest in subsolar PBH searches (LVK, ...)



Method: matched-filtering

All assuming ultracompact objects

Need to take generic compactness into account for generic ECOs



How to Search for Very Light ECO?



To probe a lighter one, make the other one heavier: larger mass ratio





Can search for much lighter ECO!

Maximum Frequency



The Extreme Mass Ratio Inspiral (EMRI)



Wikipedia

Babak et al, PRD [1703.09722]



Sensitivity to PBHs

• Can reach O(1000) events in 5 years



HG, J.Shu, Y.Zhao, PRD [1709.03500]



HG, K.Sinha, C.Sun, 1904.07871 [JCAP]

mini-EMRIs



Similar systems:

Davoudiasl, Giardino, PLB [1609.00907] Pan, Lyu, Yang, PRD [2112.10237] Barsanti et al PRL [2109.02170]

LIGO can detect (non-standard) EMRIs!

Search Strategies

- Signal is similar to continuous waves from neutron stars
- Search strategies can be employed for mini-EMRIs

targeted searches (known black holes, neutron stars as the heavier object)



✓ directed searches (where their presence is more likely)







mini-EMRI Sensitivity to ECOs

Using continuous-wave detection method (Keith, LRR [2206.06447])







- EMRIs are ideal systems for searches of subsolar ECOs
- LIGO can detect mini-EMRIs

EMRI searches can be used to probe axions (ALP)

