CATCHING BLACK HOLES WITH TIDAL DISRUPTION EVENTS

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Gravitational waves: a new way to explore the Universe
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Supervisors: Rossi E.M. (UniLei) & Lodato G. (UniMi)

Collaborators: Price D.J. (MOCA), Pfister H. (DARK-HKU), Tiengo A. (UniPv), Esposito P. (UniPv)
What are Tidal Disruption Events (TDEs)?

TDE sketch: Rees 1988 (re-adapted)
TDE snapshots: Toscani et al. in prep.

Recent reviews: Rossi et al. 2020,
Stone et al. 2020, Lodato et al. 2020
How can we see TDEs?

- debris falls back
- lightcurve \( \propto t^{-5/3} \)
- super-Eddington
- X-ray, optical and radio
- detected since 90s

Recent reviews: Saxton et al. 2020, van Velzen et al. 2020, Alexander et al. 2020, Roth et al. 2020

Artistic impression of a TDE; credits NRAO/AUI/NSF/NASA

with the accretion of material, after the disruption, TDEs can enlight **dormant** black holes
How can we see TDEs?

Gravitational wave (GW) emission from tidal disruptions

Sun-like star disrupted by a $10^6 M_\odot$ BH at 20 Mpc

$h \approx 10^{-22},$

$f \approx 10^{-4} \text{ Hz}$

See for more about TDEs and GWs: Kobayashi et al. 2004, Guillochon & Ramirez-Ruiz 2009, Stone et al. 2013
What is the GW signals from TDEs?

Toscani et al. in prep

SPH code with general relativity by Liptai and Price 2019

\[ h^{\text{TT}}(t, n) \propto \dddot{M}^{kl} \]

\[ M^{kl} = \frac{1}{c^2} \int d\mathbf{x} T_{00} x^k x^l \Rightarrow M^{kl} = \sum_a m_a x^k_a x^l_a, \]

\( h^{\text{TT}}(t, n) \propto \dddot{M}^{kl} \)  

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\( M^{kl} = \frac{1}{c^2} \int d\mathbf{x} T_{00} x^k x^l \Rightarrow M^{kl} = \sum_a m_a x^k_a x^l_a, \)

\( M^{kl} = \sum_a m_a (\dddot{x}^k x^l + 2\dddot{\dot{x}}^k \dot{x}^l + \dddot{x}^l \dot{x}^k)_a \)

\[ h_+ h_\times, h \]
What is the GW signals from TDEs?

Toscani et al. in prep
What is the GW signals from TDEs?

Toscani et al. in prep

Building a GW wave catalogue!!

spanning all the parameters space
- eccentricity
- BH spin
- orbital inclination
- penetration factor

SOON available online for everyone
What is the GW background from TDEs?

GW signal from single TDE not very strong

unlikely single detection (at least for LISA)

Pfister et al. 2021 (submitted), already on the ArXiv (2103.05883)

gravitational wave background from the entire population of TDEs

nuclear TDEs
globular TDEs

Toscani et al. 2020
What is the GW background from TDEs?

TOSCANI et al. 2020

TDEs of WDs promising to map IMBHs up to redshift 3

Deci-Hertz observatories will be crucial
Conclusions

TDEs → electromagnetic radiation

gravitational waves

very luminous light curve proportional to $t^{-5/3}$

background promising source of information

GW catalogue online soon

Deci-Hertz observatories crucial

reference for LISA, TianQin...
Thanks for your attention

Merci pour votre attention

Image credits: Martina Toscani