Poster Talks

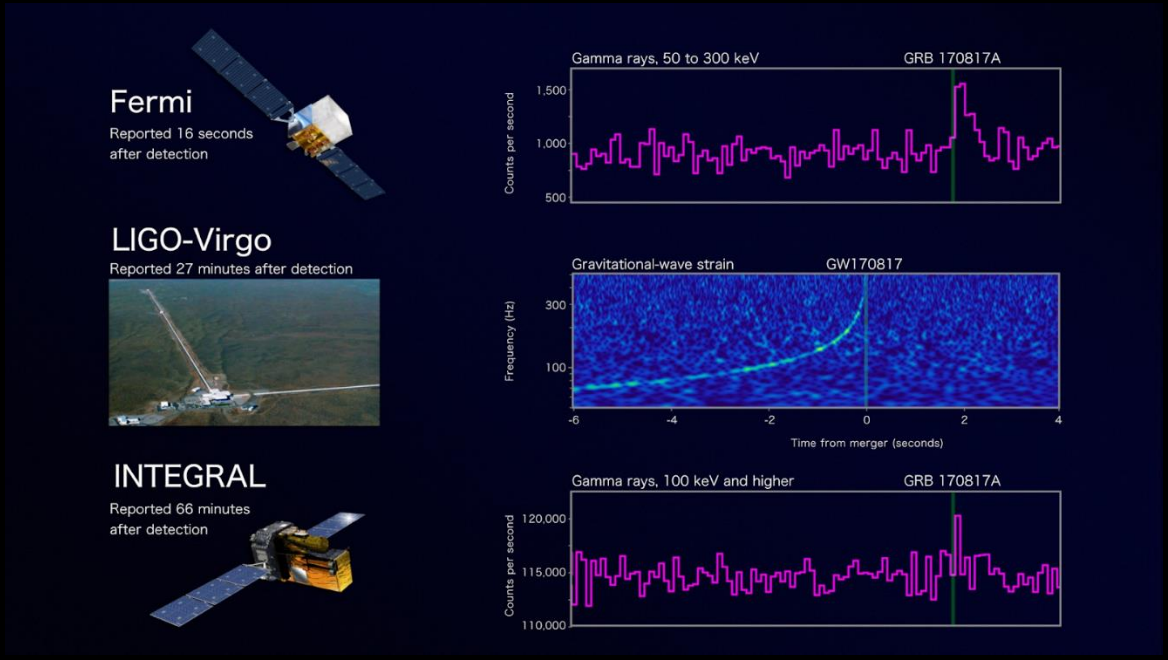
The preview session by the poster presenters today

#1

#2

Low luminous action in the sky: Are we ready?

Smaranika Banerjee on behalf of Daksha team



t = 1.7 s

t = 0 s

t = 1.7 s

Requirement?

An all sky GRB monitor with broadband energy range that can stay on alert all the time

https://heasarc.gsfc.nasa.gov/docs/objects/heapow/archive/transients/gw170817.html

Introducing Daksha

Courtesy : A. Balasubramanian

Pair of satellites for all-sky high energy transient monitoring purpose

PI: Dr. Varun Bhalerao, IIT Bombay, India

Team:

INDIAN INSTITUTE OF TECHNOLOGY BOMBAY

IUCAA

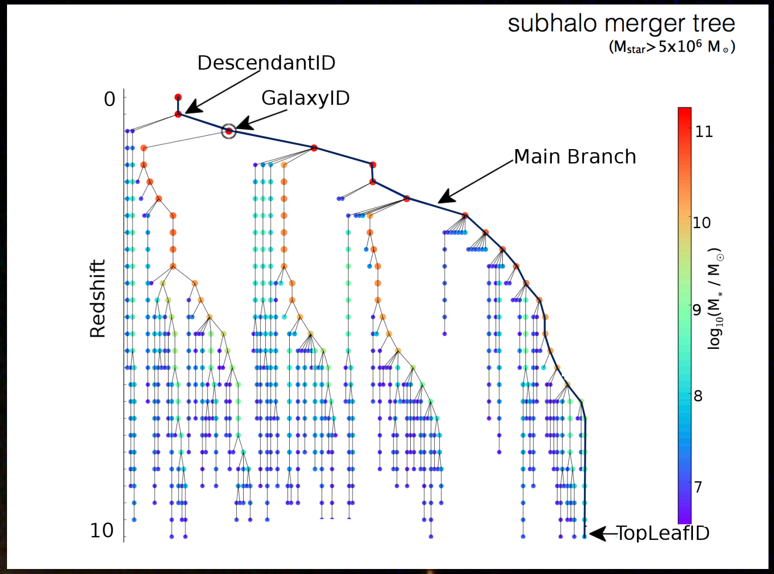
tifr

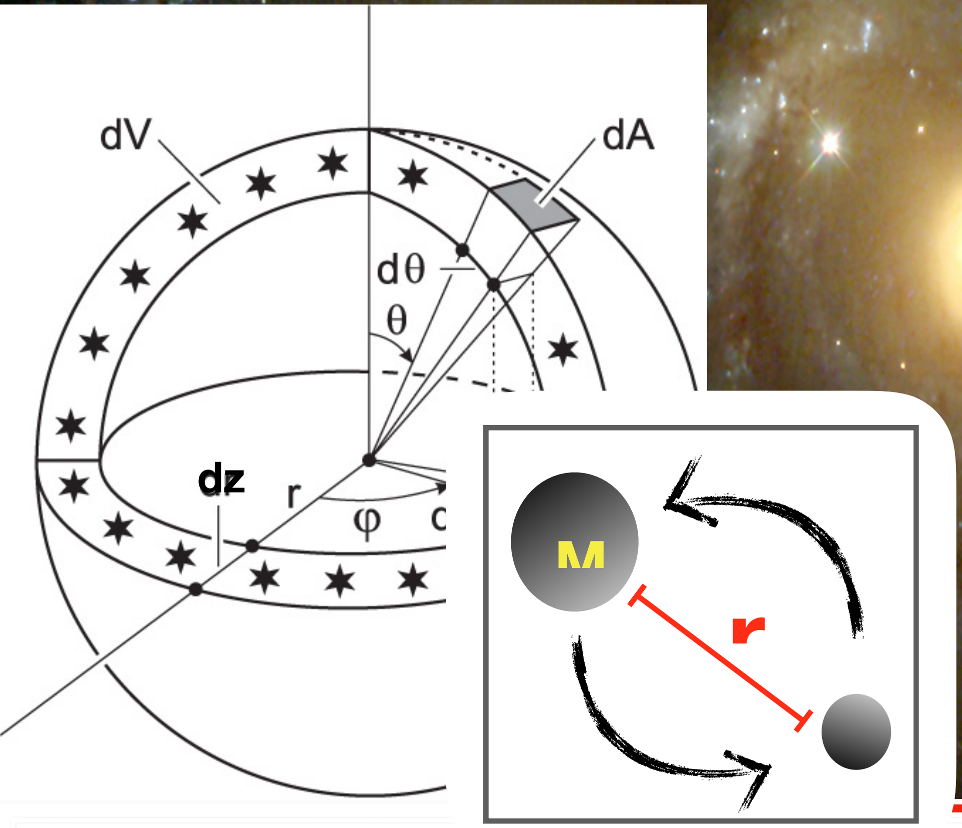
Physical Research Laboratory (PRL)

#3

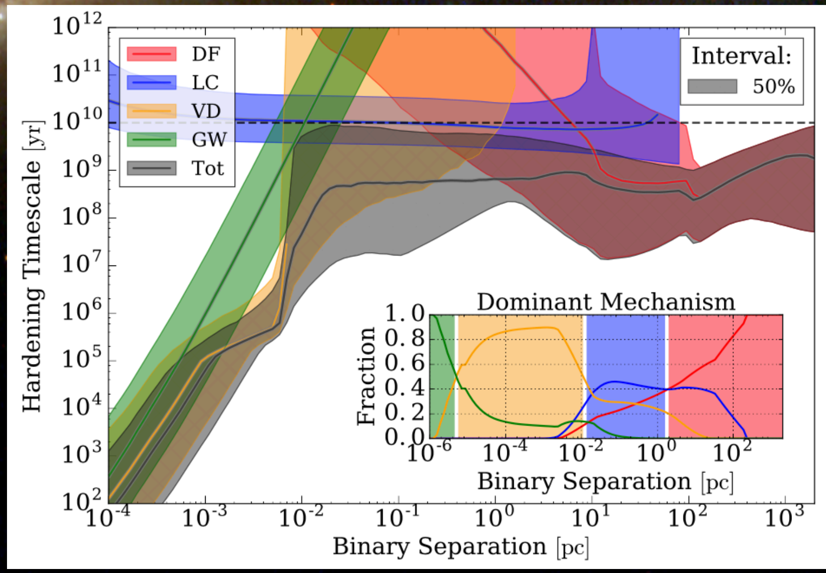
Co-evolution of super massive BH w. galaxies

- Stochastic GW background— isotropic/anisotropic
- Galaxies merger (above kpc) modelling
- BH merger (sub-kpc) dynamics modelling





$$h_c^2(f) = \int_0^\infty dz \int_0^\infty d\mathcal{M} \boxed{\frac{d^3N}{dz\,d\mathcal{M}\,d\ln f_r}} h^2(f_r),$$

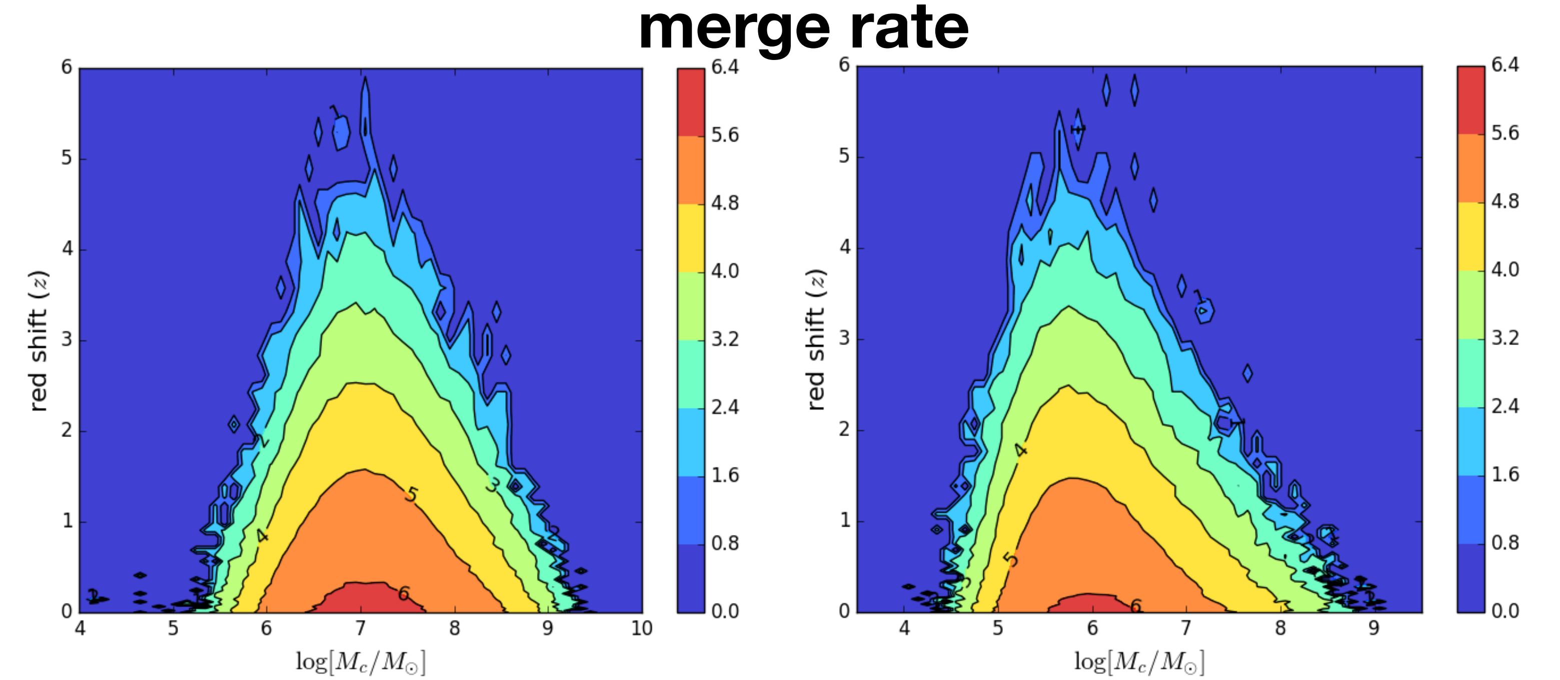


Mon.Not.Roy.Astron.Soc. 483 (2019) no.1, 503-513

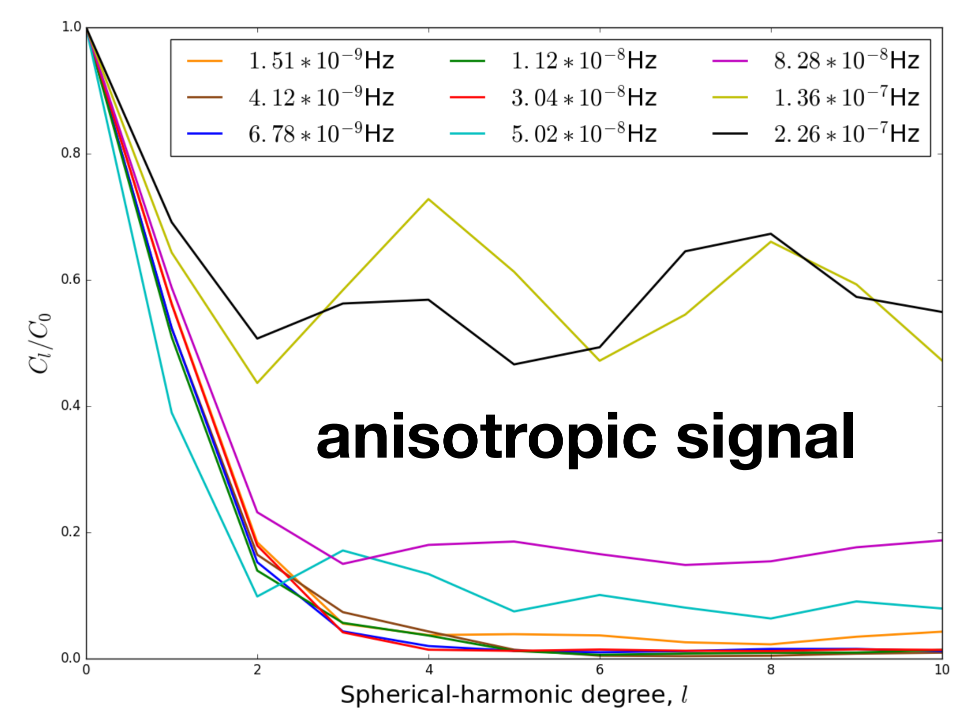
Qing Yang, BH, Xiao-Dong Li

L-galaxies 2013 **L-galaxies 2015**

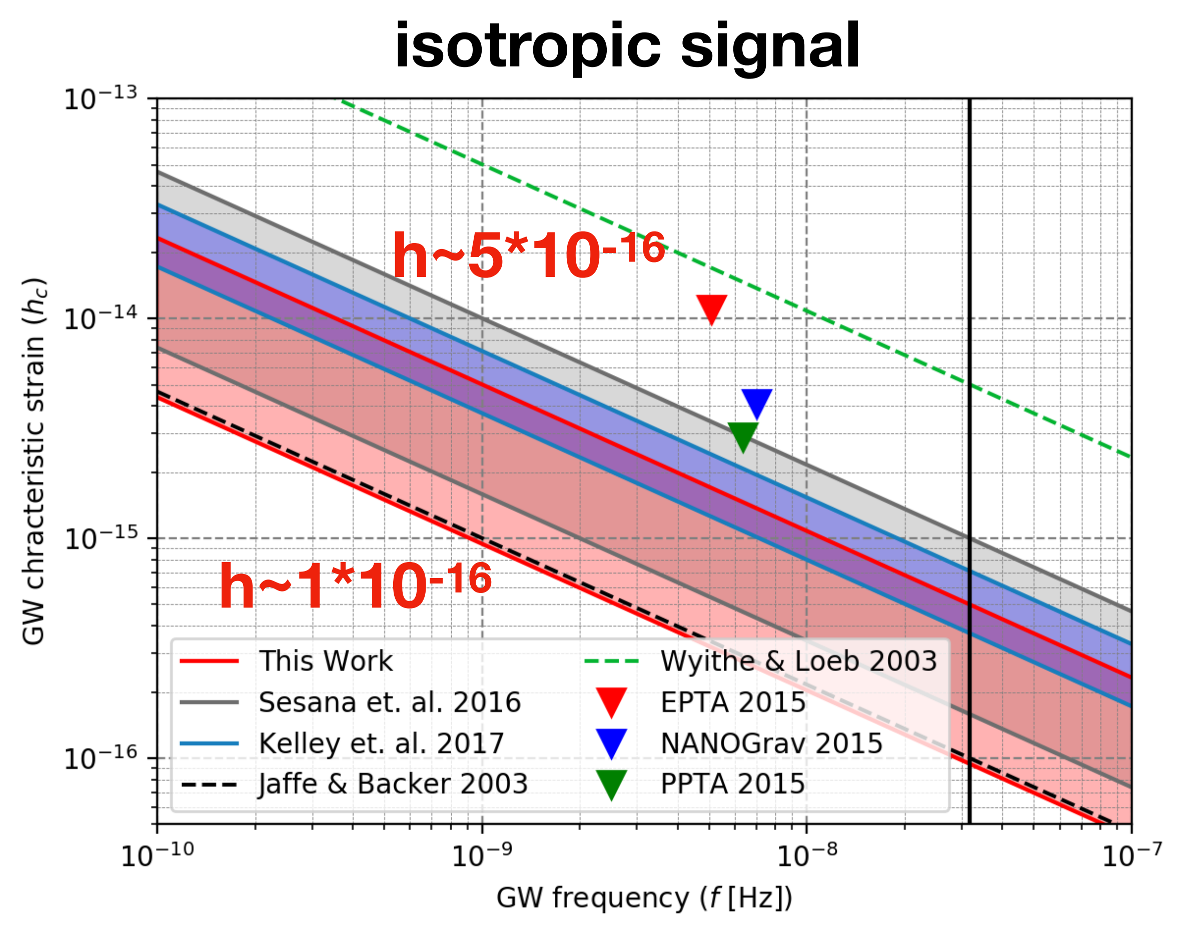
merge rate



anisotropic signal



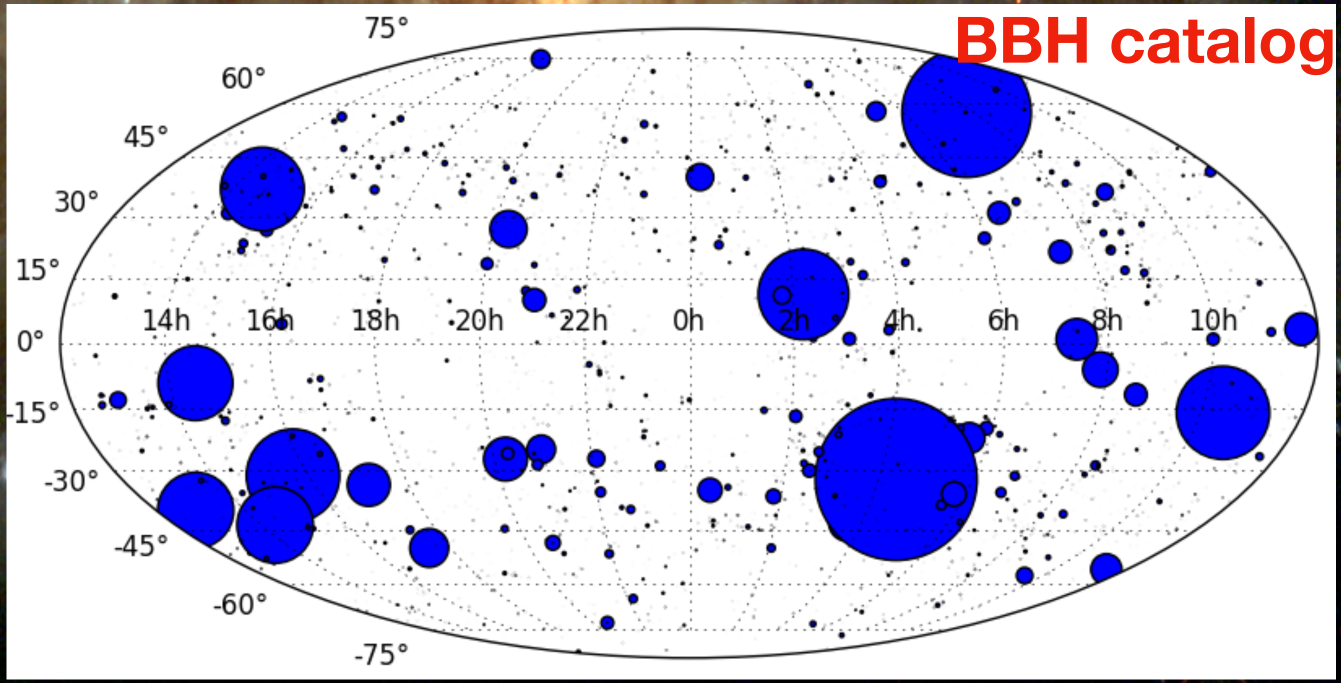
isotropic signal



$h \sim 5*10^{-16}$

$h \sim 1*10^{-16}$

BBH catalog



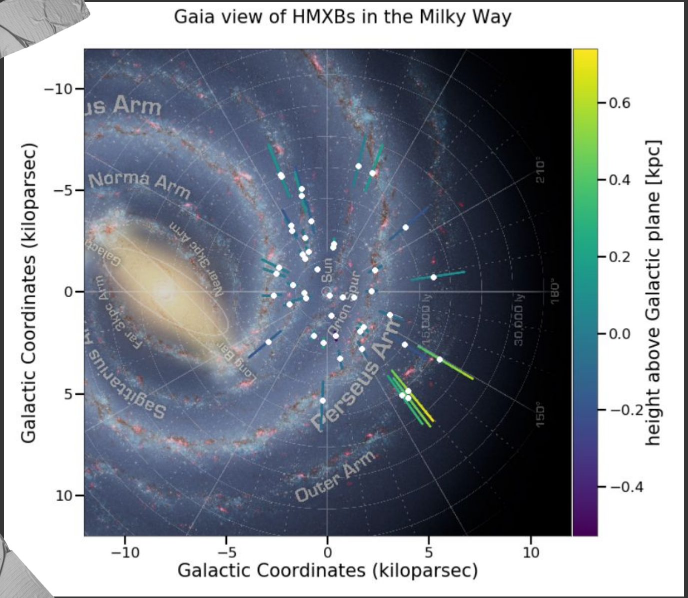
Mon.Not.Roy.Astron.Soc. 483 (2019) no.1, 503-513

Qing Yang, BH, Xiao-Dong Li

#4

Exploring the *GAIA* view of High Mass X-ray Binaries

Federico García, **Sylvain Chaty**, Francis Fortin *(CEA/AIM)*, E. Chassande-Mottin, E. Porter *(APC France)*



Tasks:

- **Produce an updated list of confirmed HMXBs** with their parameters, including orbital period, eccentricity, companion masses and radial velocities

- **Cross-match with GAIA/DR2 data** to estimate their distances and peculiar velocities → **We find excellent matches for 46 HMXBs: 3 BHs + 43 NSs**

- **Obtain peculiar systemic velocity of each HMXB**, assuming a Galactic rotation model

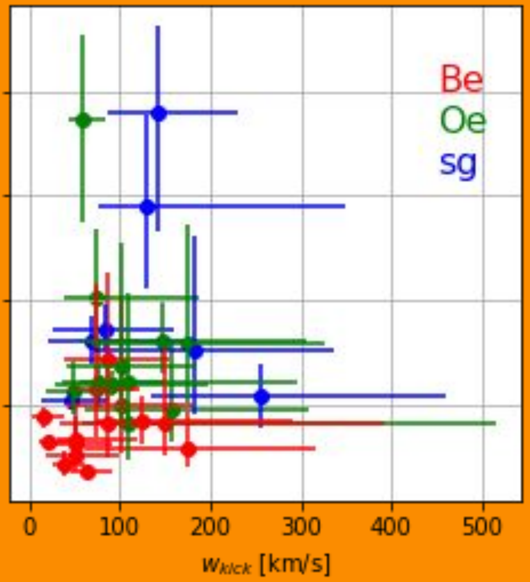
- **Build a model to infer binary properties before SN explosion and NS kick**, assuming that peculiar systemic velocities and eccentricities are due to the SN

- Using a MCMC scheme we constrain the NS kick and the mass lost by the system during the SN explosion

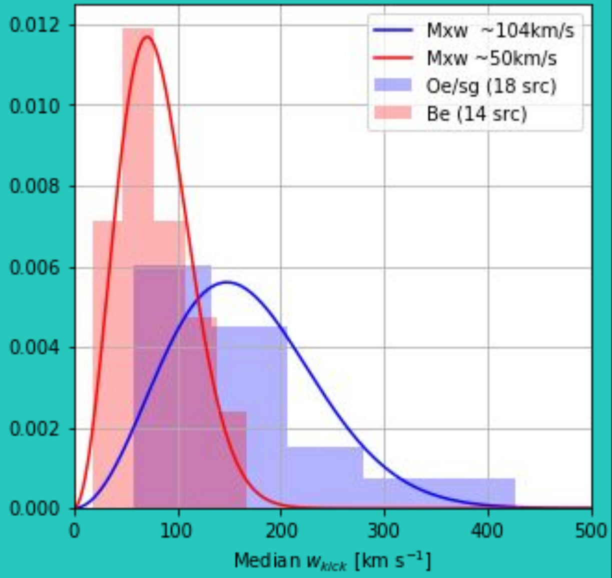
(Garcia et al. 2019 to be submitted soon)

Federico Garcia (garcia@astro.rug.nl) & Sylvain Chaty (sylvain.chaty@u-paris.fr)

We derive NS kicks and pre-SN masses for each HMXB subtype: Oe, sg, Be



Oe- and **sg-XB** show similar properties, with more massive progenitors and stronger kicks than **Be-XB**



NS kicks characterized by Maxwellian distrib. with **<v>=50 km/s for Be** and **<v>=104 km/s for Oe/sg**

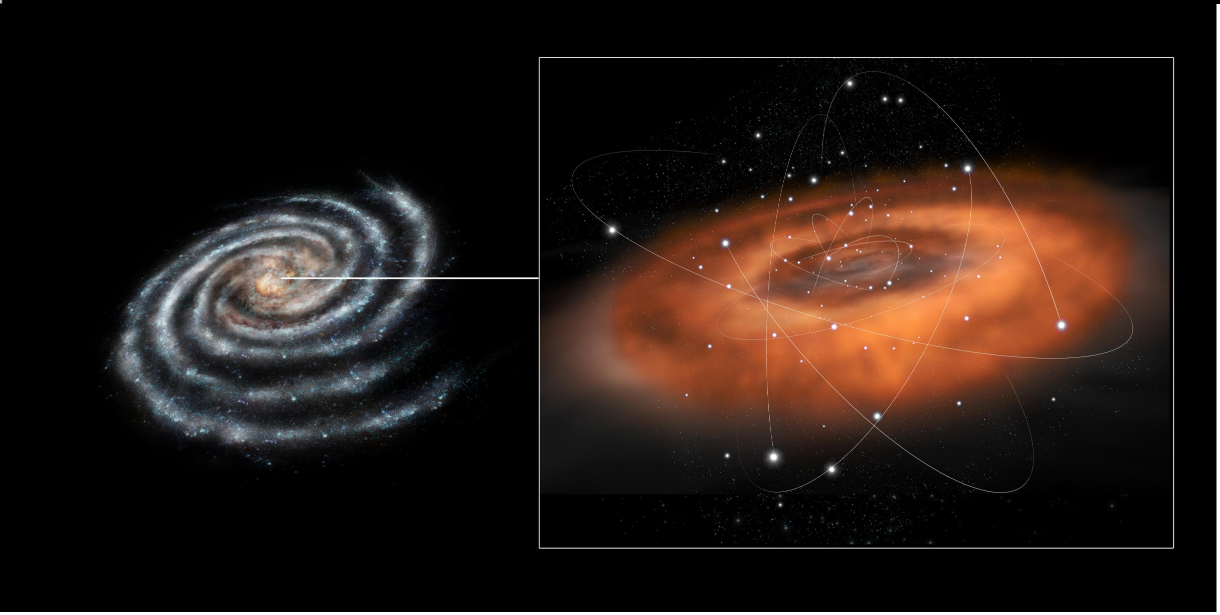
NS kicks have a strong impact both on NS-NS & BH-NS populations and on their merger rates. Pre-SN masses are primordial to constrain binary evolution and SN models.

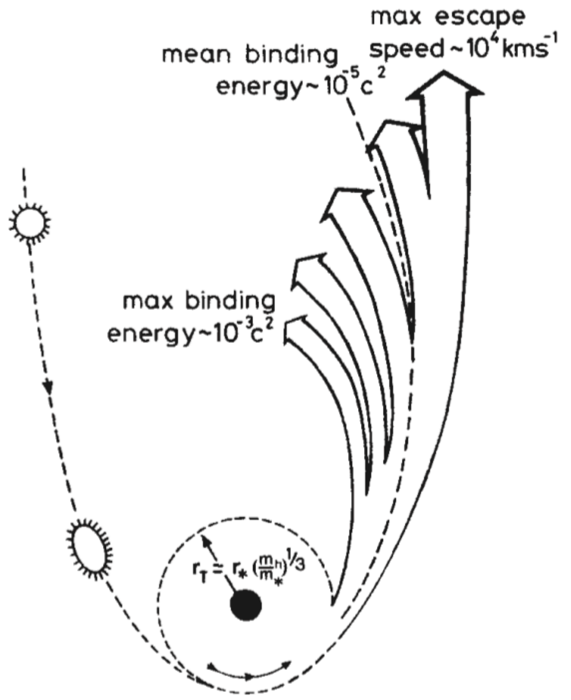
🤔 ***Interested? see our poster for more info!***

#5

Light Curve of Partial Tidal Disruption Events

Jin-Hong Chen & Rong-Feng Shen
School of Physics and Astronomy, Sun Yat-Sen University



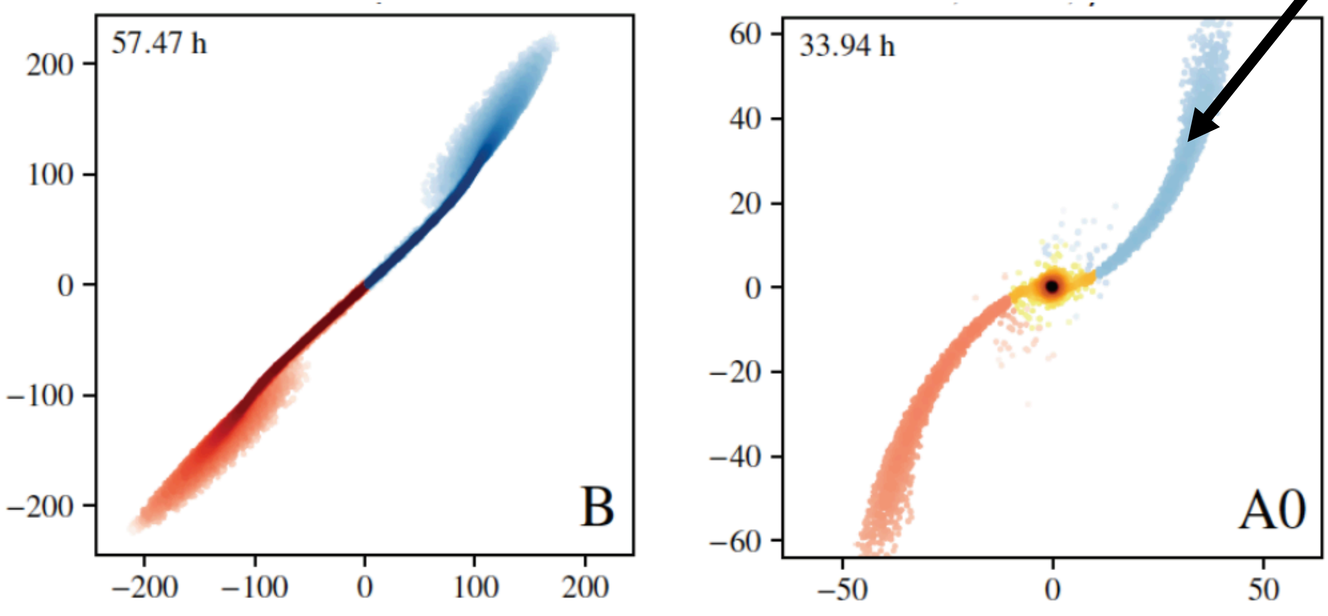


Rees, 1988

Light Curve of Partial Tidal Disruption Events

Jin-Hong Chen & Rong-Feng Shen
School of Physics and Astronomy, Sun Yat-Sen University

Thinner debris stream



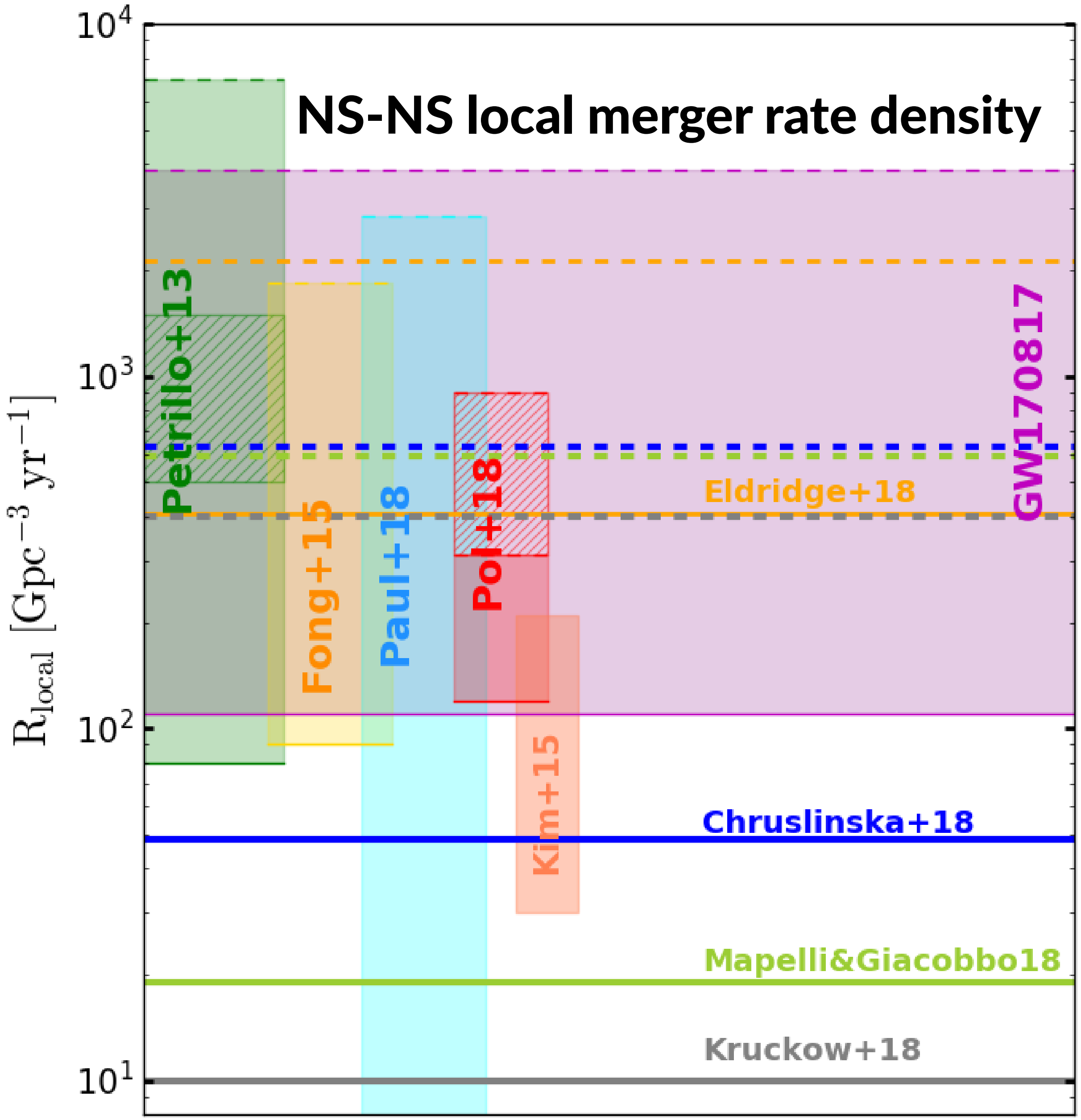
Gafton & Rosswog, 2019

Produce no outflow
Sub-Eddington accretion
Radiate soft X-rays

#6

Poster no 6

Martyna Chruślińska
(read: Hroo-shlin-ska)
m.chruslinska@astro.ru.nl
Radboud University, NL



population synthesis

———

- - - - - -

short GRBs

🟩 🟨 🟦

Milky Way NS-NS binaries

🟥 🟧

All methods use one particular ingredient…

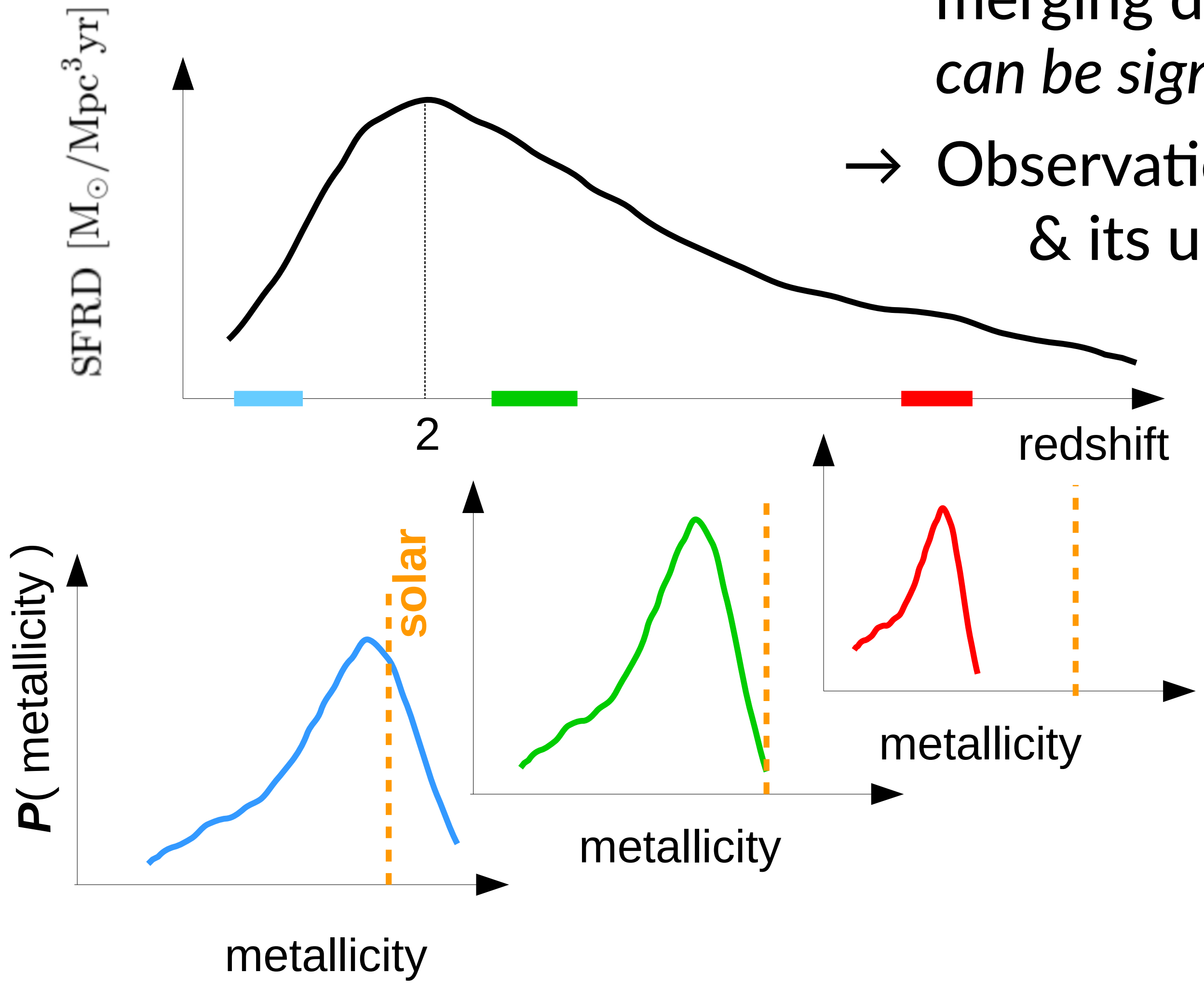
Poster no 6

Martyna Chruślińska
(read: Hroo-shlin-ska)
m.chruslinska@astro.ru.nl
Radboud University, NL

cosmic SFR density & its distribution over metallicities

→ Impact on the properties of merging double compact objects *can be significant*

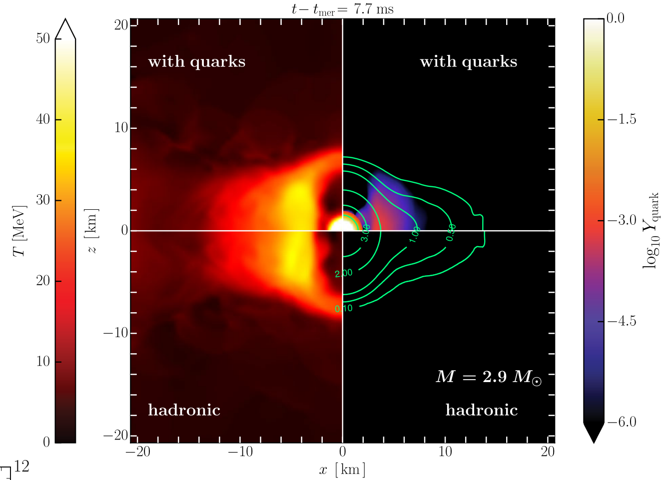
→ Observation-based distribution & its uncertainty

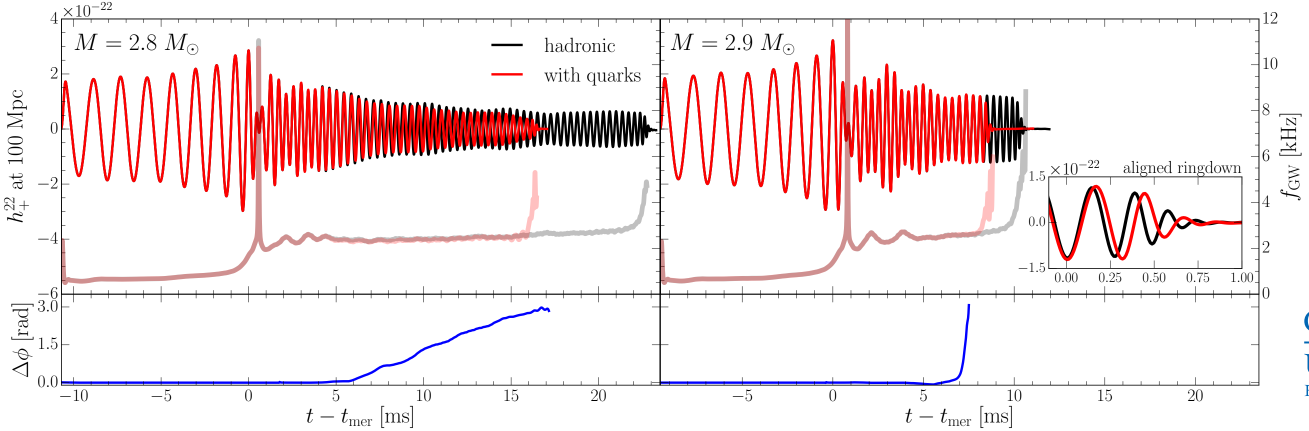


#7

Can quarks be seen in gravitational waves?

- We have investigated the impact of a hadron-quark phase transition in a neutron star merger at finite temperatures.
- Small fraction of quarks is present in hot regions at all times.
- This causes a de-phasing of the waveform compared to the hadronic case. The ring-down is also modified.





Elias Roland Most

V. Dexheimer, L.J. Papenfort,
H. Stöcker, L. Rezzolla

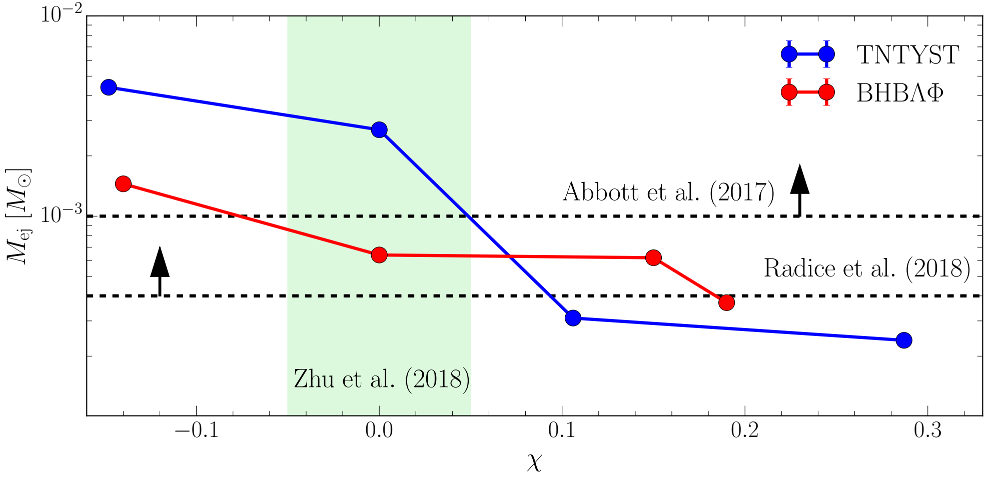
GOETHE UNIVERSITÄT FRANKFURT AM MAIN

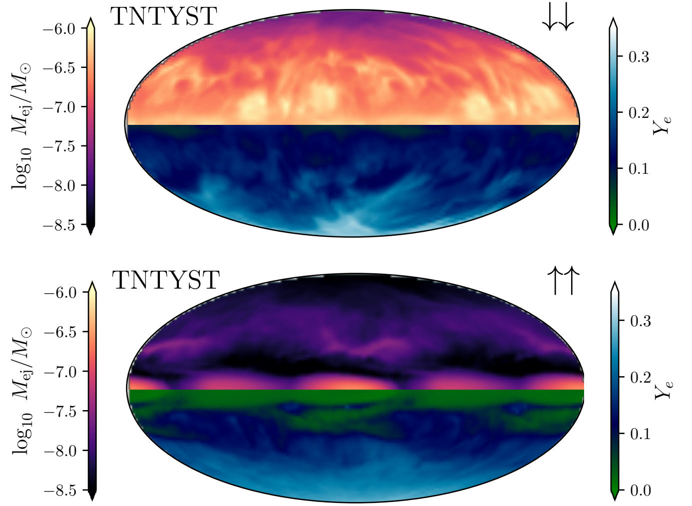
FLATIRON INSTITUTE
Center for Computational Astrophysics

E.R.Most *et al.* Phys. Rev. Lett., 122:061101, 2019

Impact of high spins on mass ejection

- We have investigated the impact of high spins on the dynamical mass ejection in neutron star mergers.
- Spins with millisecond periods aligned with the orbital angular momentum can suppress the mass ejection by up to one order of magnitude ($M_{\rm ej} \simeq 10^{-4} M_\odot$).
- Misaligned spins can enhance it.





Elias Roland Most
L.J. Papenfort, A. Tsokaros
L. Rezzolla

GOETHE UNIVERSITÄT FRANKFURT AM MAIN
FLATIRON INSTITUTE
Center for Computational Astrophysics

E.R.Most *et al.* ApJ, in press, 1904.04220, 2019

#8

Signatures of Quark-Hadron Phase Transitions in General-Relativistic Neutron-Star Mergers

Veronica Dexheimer

in collaboration with Elias Most, Jens Papenfort,
Matthias Hanauske, Luciano Rezzolla and Horst Stöcker

Phys. Rev. Lett. 122 (2019) no.6, 061101
ArXiV 1807.03684

KENT STATE
UNIVERSITY

PHAROS
THE MULTI-MESSENGER
PHYSICS AND ASTROPHYSICS
OF NEUTRON STARS

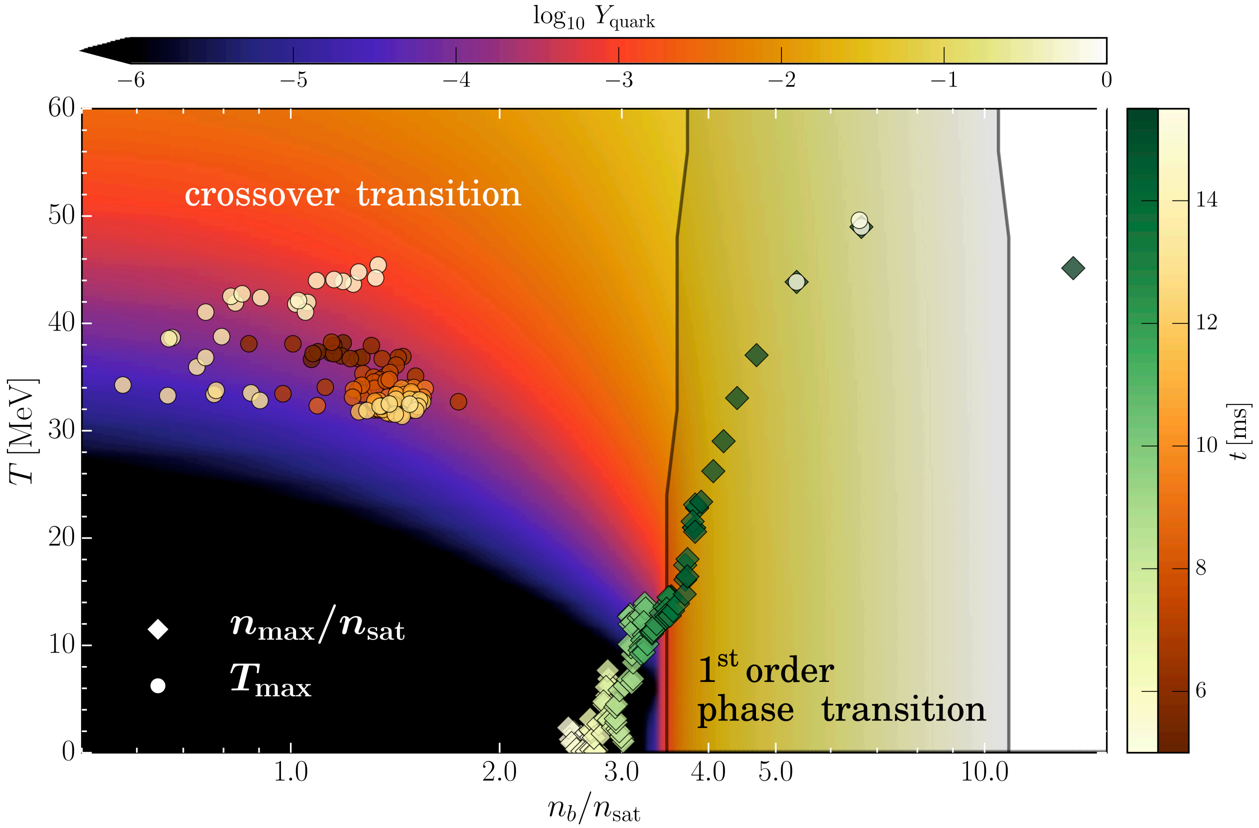
NSF

Results of Simulation on the QCD Phase Diagram

KENT STATE UNIVERSITY

Veronica Dexheimer
Phys. Rev. Lett. (2019)

- ★ solve general-relativistic hydrodynamics equations using 3D Chiral Mean Field (CMF) equation of state



- ★ deconfinement to quark matter takes place in binaries with final masses >2.7 M_{sun}
- ★ first-order phase transition induced collapse generates large temperatures and densities (but not charge fraction) in the center of the hypermassive-star

#9

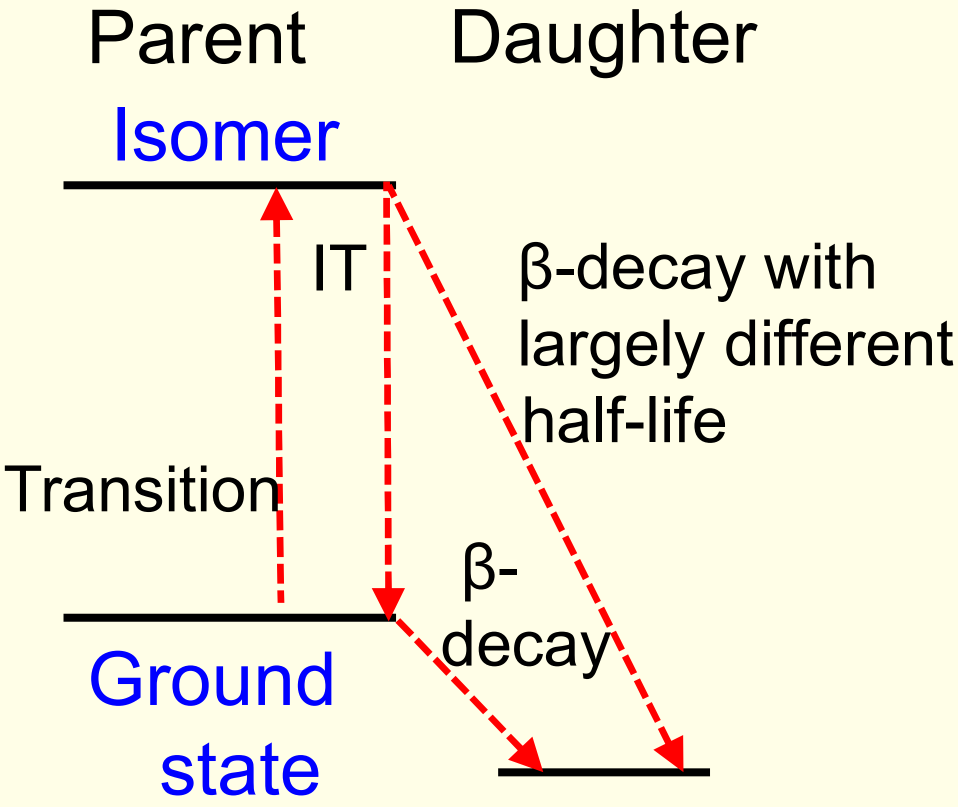
#10

Effects of isomers of Sn, Sb, Te, and I on a kilonova associated with neutron star mergers

Shin-ichiro Fujimoto
(National Institute of Technology, Kumamoto College)
Masa-aki Hashimoto
(Kyushu Univ.)

Isomer

= quasi-stable excited state



Parent

Daughter

Isomer

IT

β-decay with largely different half-life

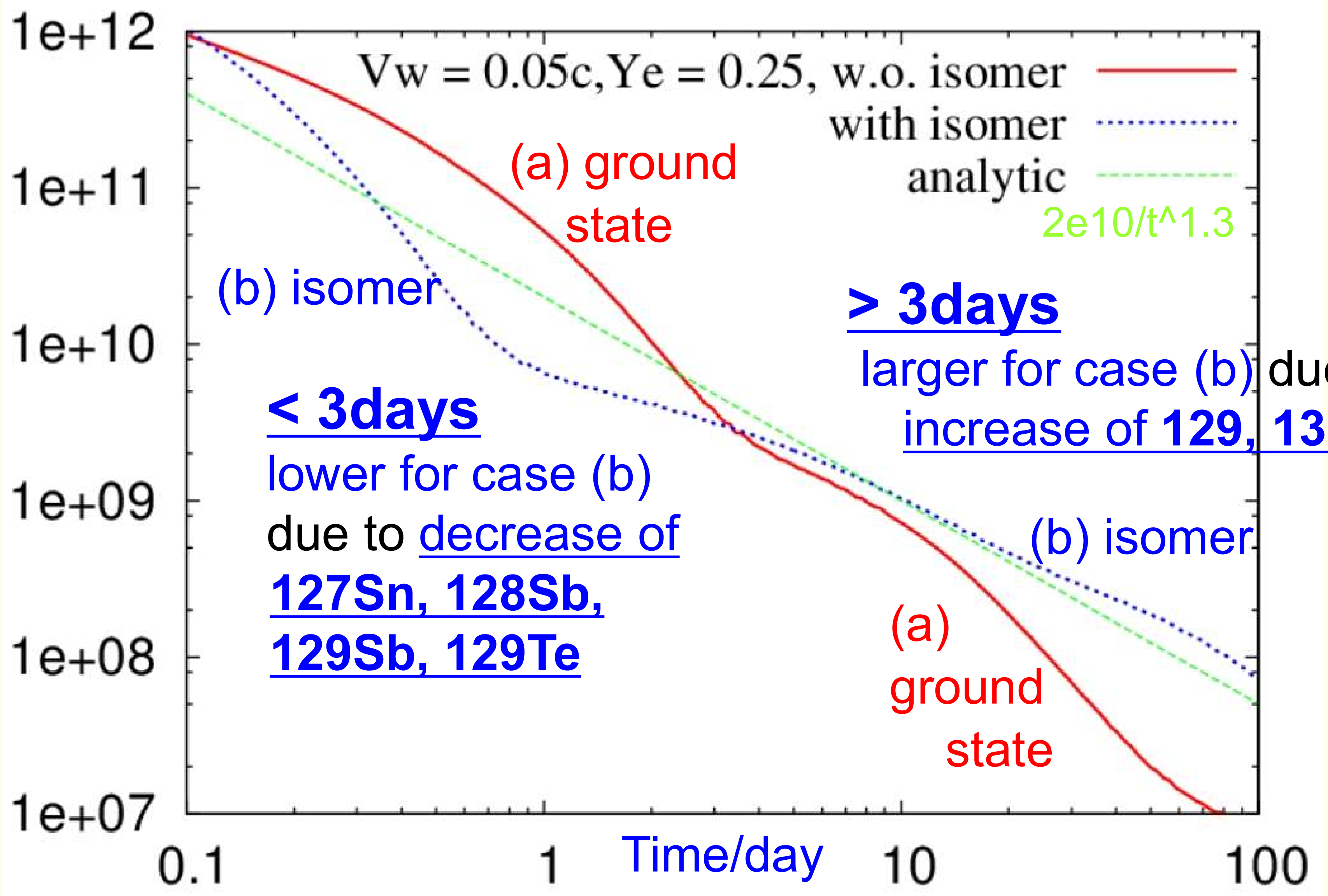
Transition

β-decay

Ground state

One expect that light-curve may change due to much longer or shorter half-lives of the isomers, if we take into account isomers.

Energy generation rates (erg/g/s)



< 3days

lower for case (b) due to decrease of **127Sn, 128Sb, 129Sb, 129Te**

> 3days

larger for case (b) due to increase of **129, 131Te**

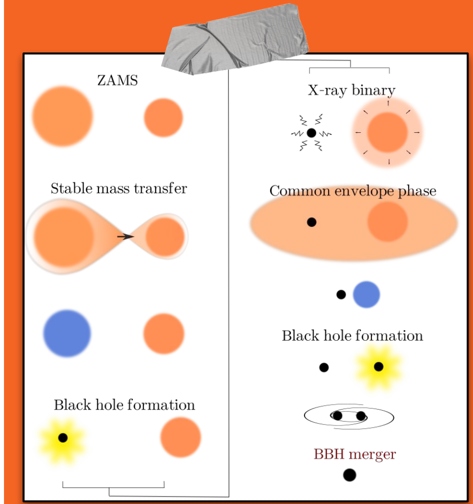
We examine (1) dependence on Ye and Vw and (2) impact of isomers on a light curve of a kilonova

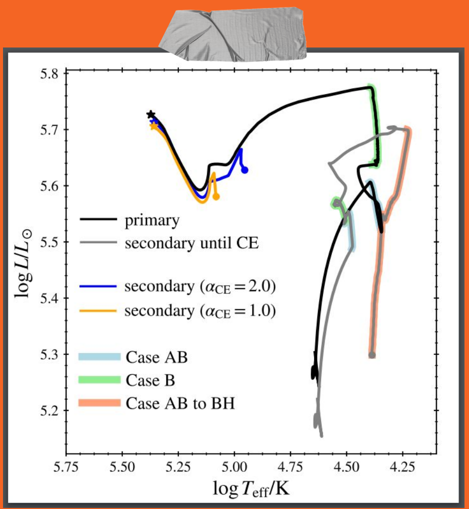
#11

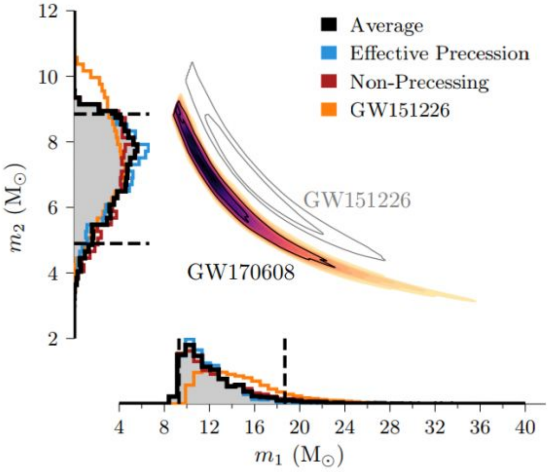
Université de Paris cea AIM APC Labex UnivEarthS USPC Université Sorbonne Paris Cité

Exploring the progenitors of low-mass BBH mergers detected by LIGO/Virgo

Federico García, **Sylvain Chaty** (AIM/CEA France)
A.Simaz Bunzel (IAR Argentina) E.Porter, E.Chassande-Mottin (APC France)







Abbott+2017

GW151226 (z=0.09)

$$\mathcal{M}_{\rm chirp} = 8.83^{+0.74}_{-0.66}$$
$$q_{\rm BBH} = 0.56^{+0.44}_{-0.49}$$

(100% CI de-redshifted)

GW170608 (z=0.07)

$$\mathcal{M}_{\rm chirp} = 7.91^{+0.43}_{-0.37}$$
$$q_{\rm BBH} = 0.69^{+0.31}_{-0.56}$$

(100% CI de-redshifted)

We used **MESA 1D-stellar evolution code** to model binary systems leading to BBH mergers

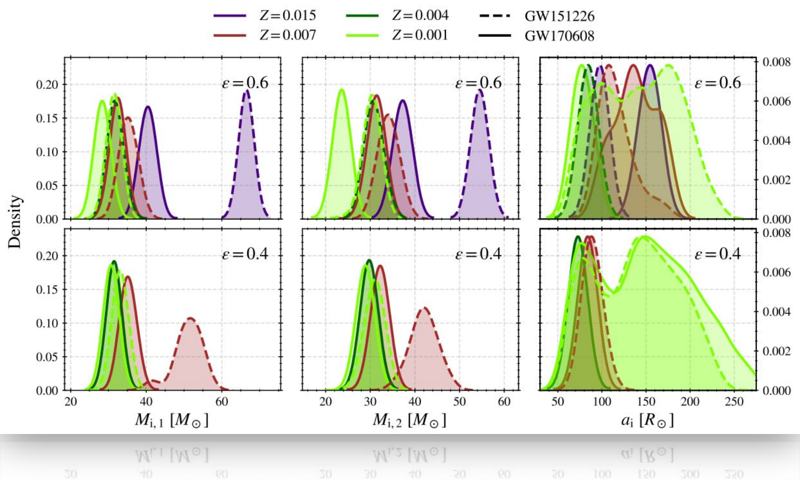
We incorporated **a numerical treatment of unstable mass-transfer** for **common-envelope** ejection and a **prescription for BH formation**

We built **a grid of ~50 000 runs** considering different values of stable (***ε***) and unstable (***α_{CE}***) MT efficiency, & metallicity (***Z***) to find **binary progenitors** compatible with **GW170608/GW151226**

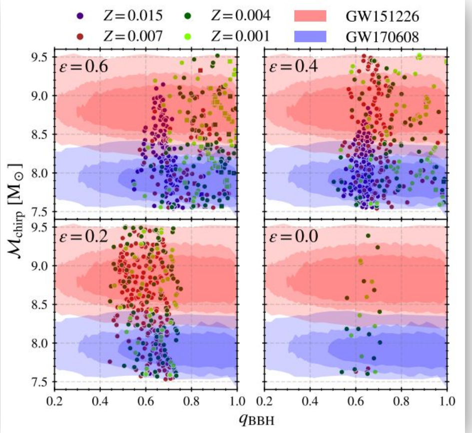
Federico Garcia (garcia@astro.rug.nl) & Sylvain Chaty (sylvain.chaty@u-paris.fr)

BPS-like approach (10^7 binaries) based on our 50 000 MESA simulations

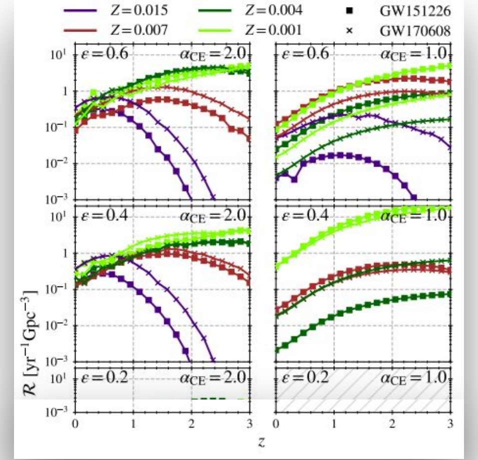
Progenitor properties



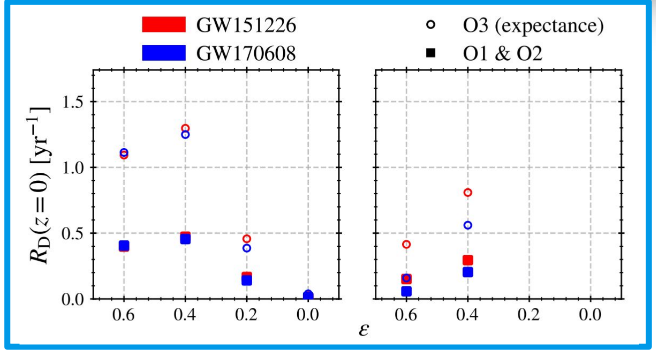
BBH properties



Merger-rate estimates



- **Progenitor properties:** according to metallicity & mass-transfer efficiency
- Distributions of **BBH mass-ratios** and **time-delays**
- **Merger-rate estimates**: comparison with O1/O2 runs from LIGO/Virgo and **O3 expectations**.

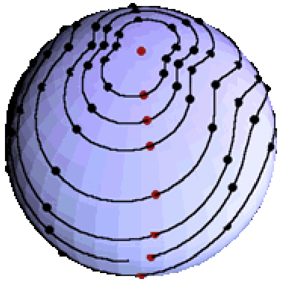


Interested? See our poster for more info!
(Garcia et al. 2019 to be submitted soon)

#12

#13

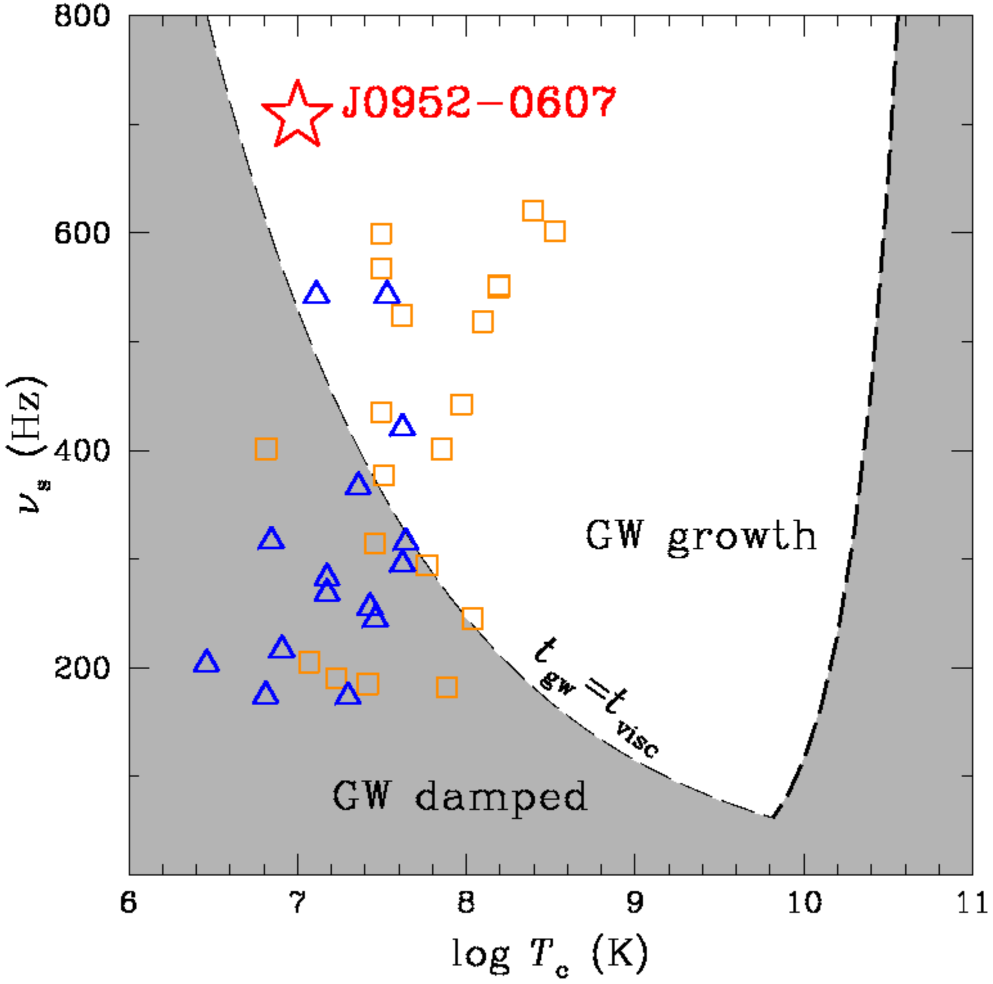
#14


Hanna+Owen

Using electromagnetic observations to search for and constrain gravitational waves from pulsars

HAVERFORD
COLLEGE

Wynn C.G. Ho (Haverford, USA), Andrey I. Chugunov (Ioffe Institute, Russia), Craig O. Heinke (Alberta, Canada)



R-mode fluid oscillation

- mode growth by gravitational wave emission, t_{gw} (ν_s)
- mode damped by viscosity, t_{visc} (ν_{s}, T_c)
- instability window: $t_{gw}(\nu_s) = t_{visc}(\nu_s, T_c)$

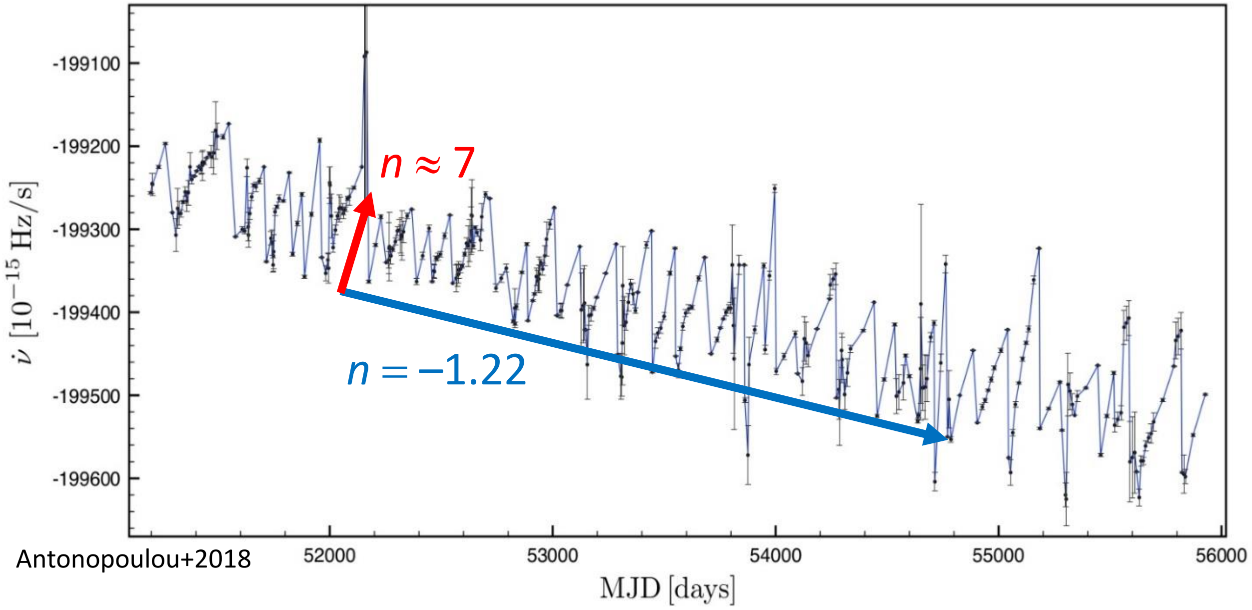
- GW searches for r-modes in pulsars

- observations of millisecond pulsars and low-mass X-ray binaries
  - PSR J0952–0607
    - 2nd fastest spinning neutron star ($\nu_s = 707$ Hz)
    - radio and gamma-ray detection and GW search
    - **X-ray detection and T_c constraint**

HAVERFORD
COLLEGE

Using electromagnetic observations to search for and constrain gravitational waves from pulsars

Wynn C.G. Ho (Haverford, USA), Danai Antonopoulou (Nicolaus Copernicus Astronomical Center, Poland),
Zaven Arzoumanian (NASA Goddard Space Flight Center, USA), Slavko Bogdanov (Columbia, USA),
Teruaki Enoto (Kyoto, Japan), Cristobal M. Espinoza (Santiago de Chile, Chile), Paul S. Ray (Naval Research Laboratory, USA)

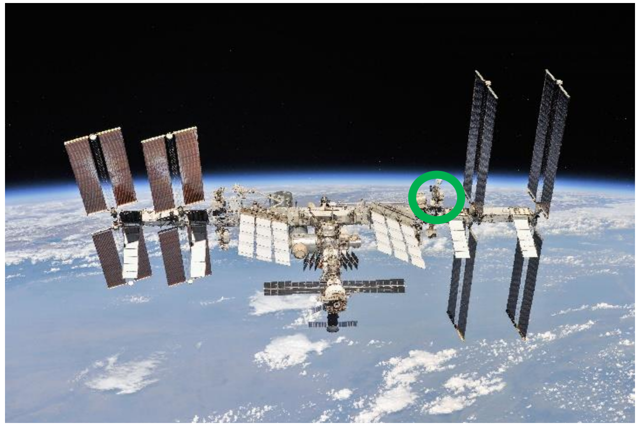


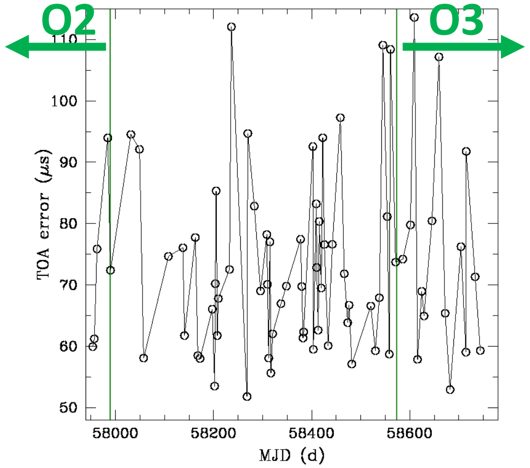
Antonopoulou+2018

- Pulsar braking index $n = \ddot{\nu}\nu/\dot{\nu}^2$
  - pulsar observations: 13 with $n <\sim 3$
  - $n = 3$ for magnetic dipole, $n = 5$ for GW mountain
  - $n = 7$ for GW r-mode

- PSR J0537–6910 (aka Big Glitcher)
  - spin frequency $\nu = 62$ Hz
  - glitch rate ~ 3.5/yr

  - 1999–2011: timed using *RXTE*
  - **July 2017–present: timed using *NICER***



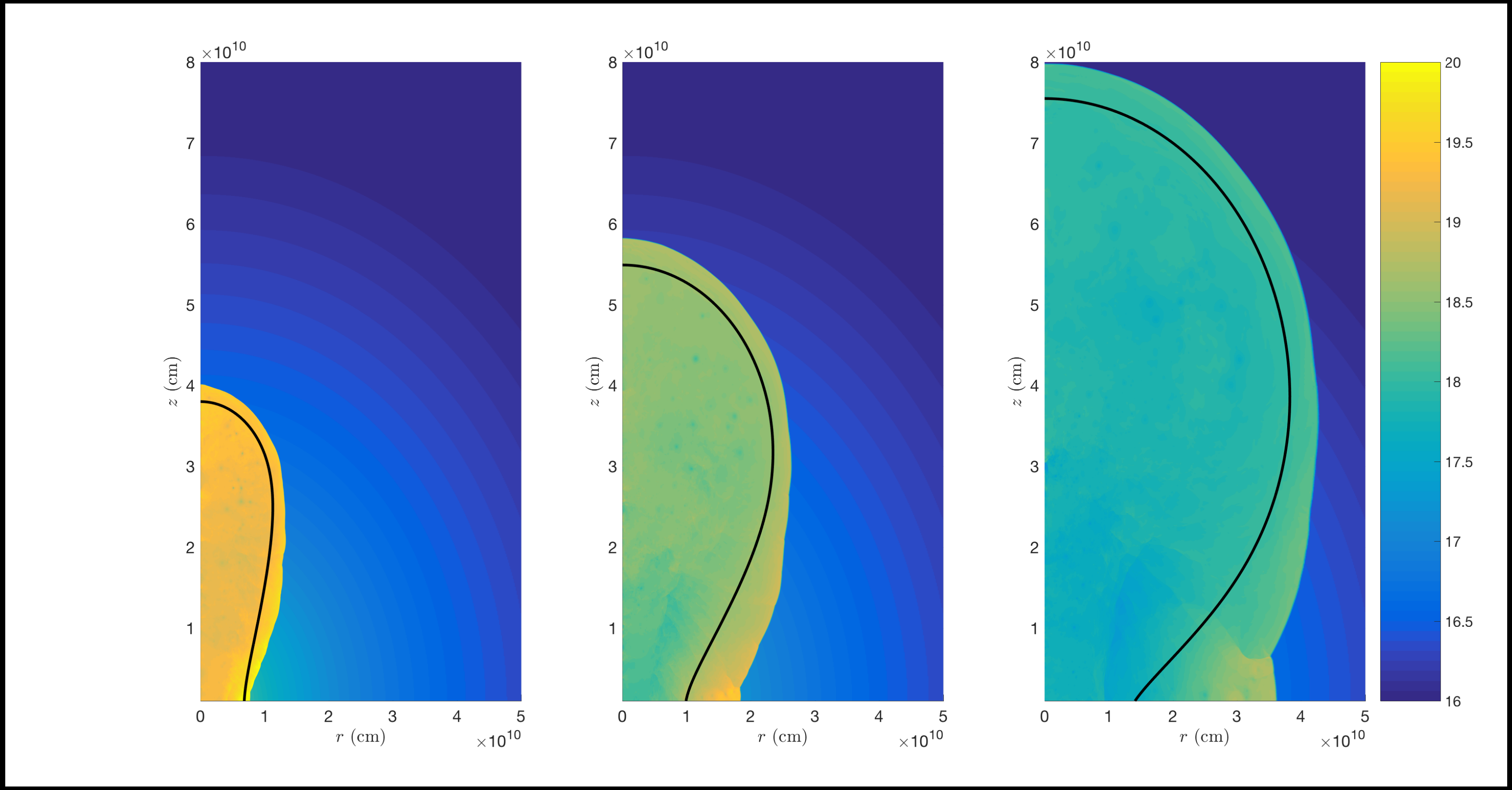


#15

The Propagation of Choked Jet Outflows

Christopher Irwin, HUJI/TAU

Collaborators: Tsvi Piran (HUJI), Ehud Nakar & Ore Gottlieb (TAU)

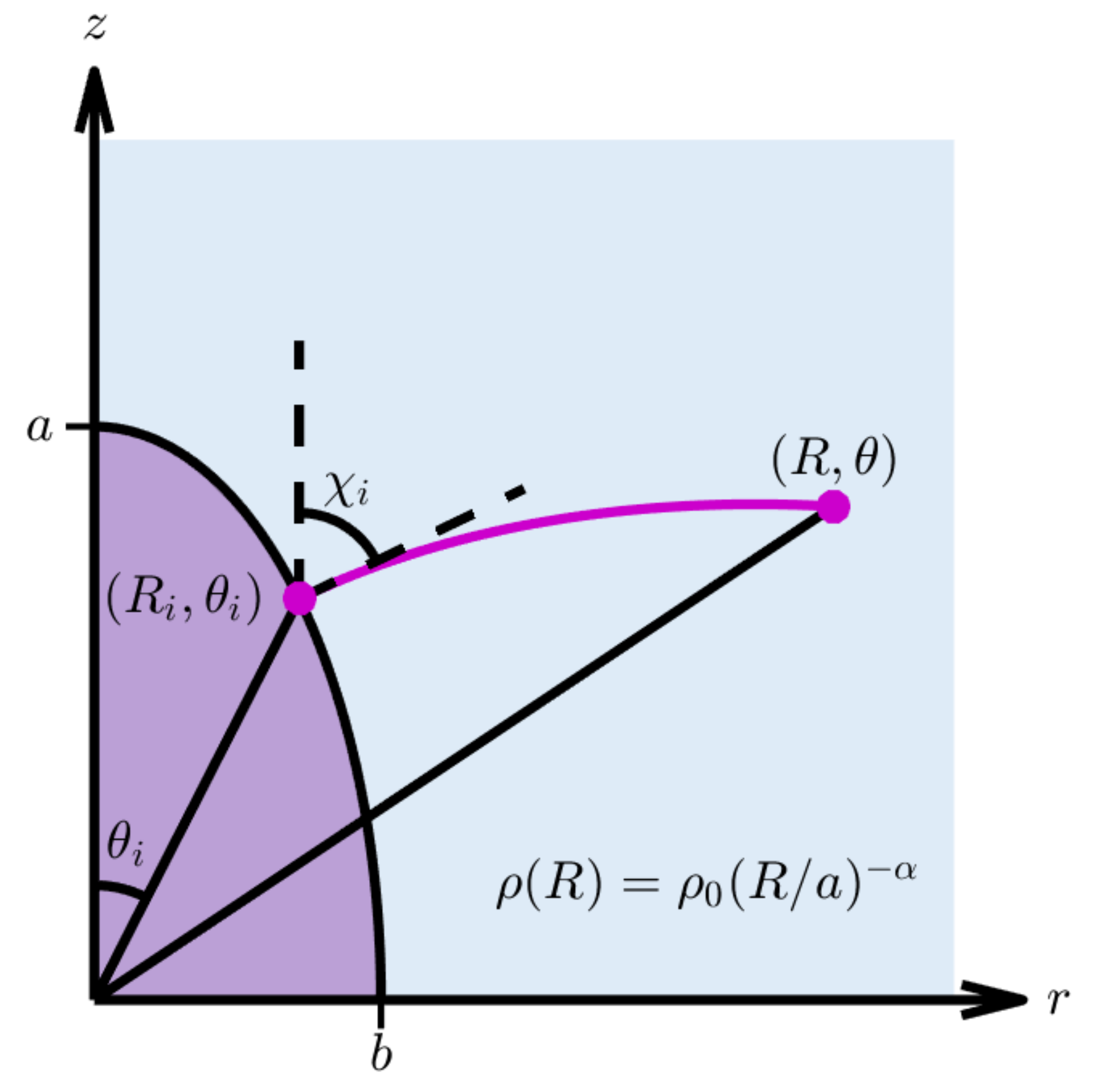


TEL AVIV UNIVERSITY אוניברסיטת תל אביב

arXiv: 1907.04985

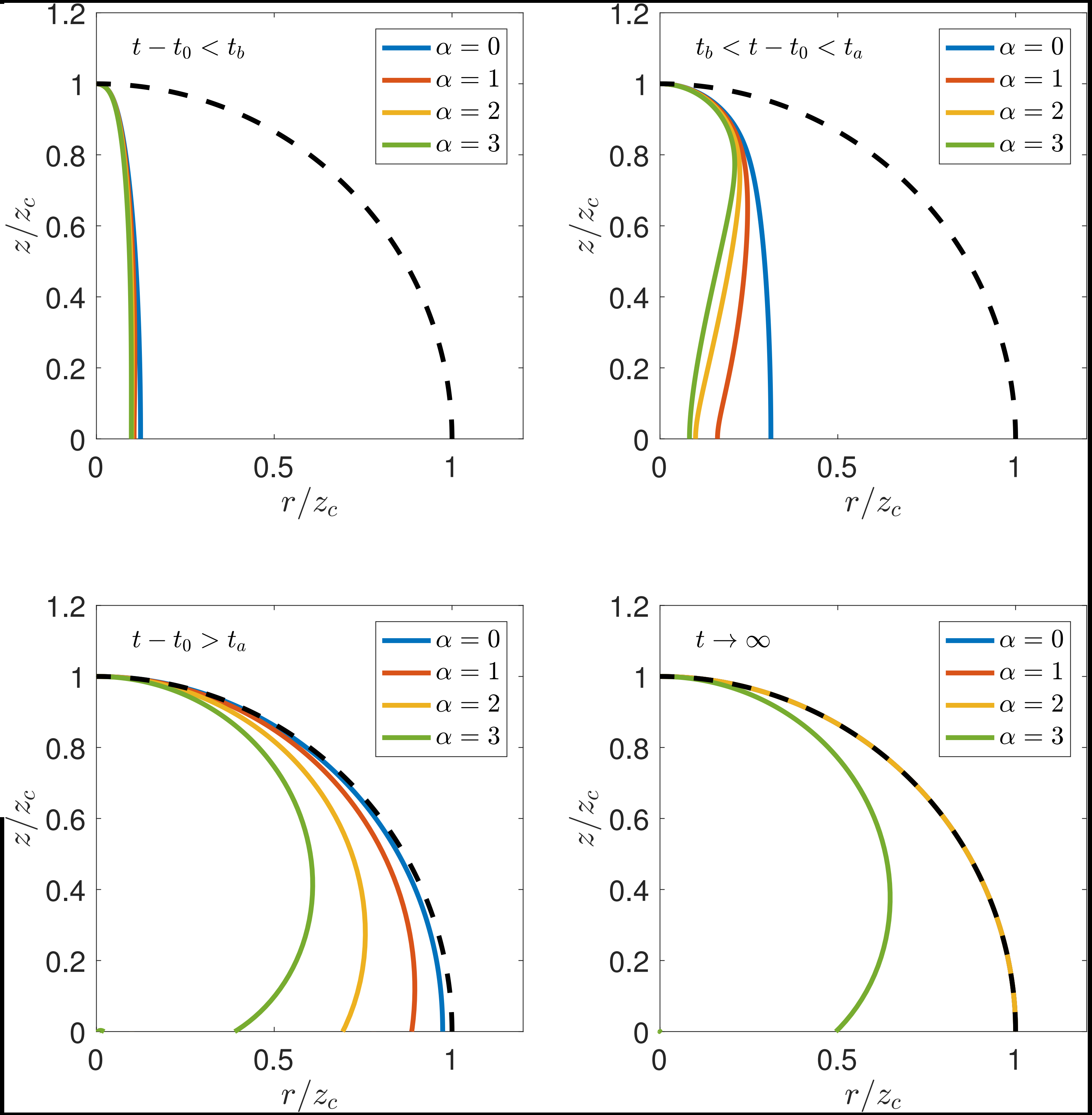
האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM

What happens to initially jetted outflows after the jet is switched off?



Initial conditions

Subsequent evolution



#16

#17

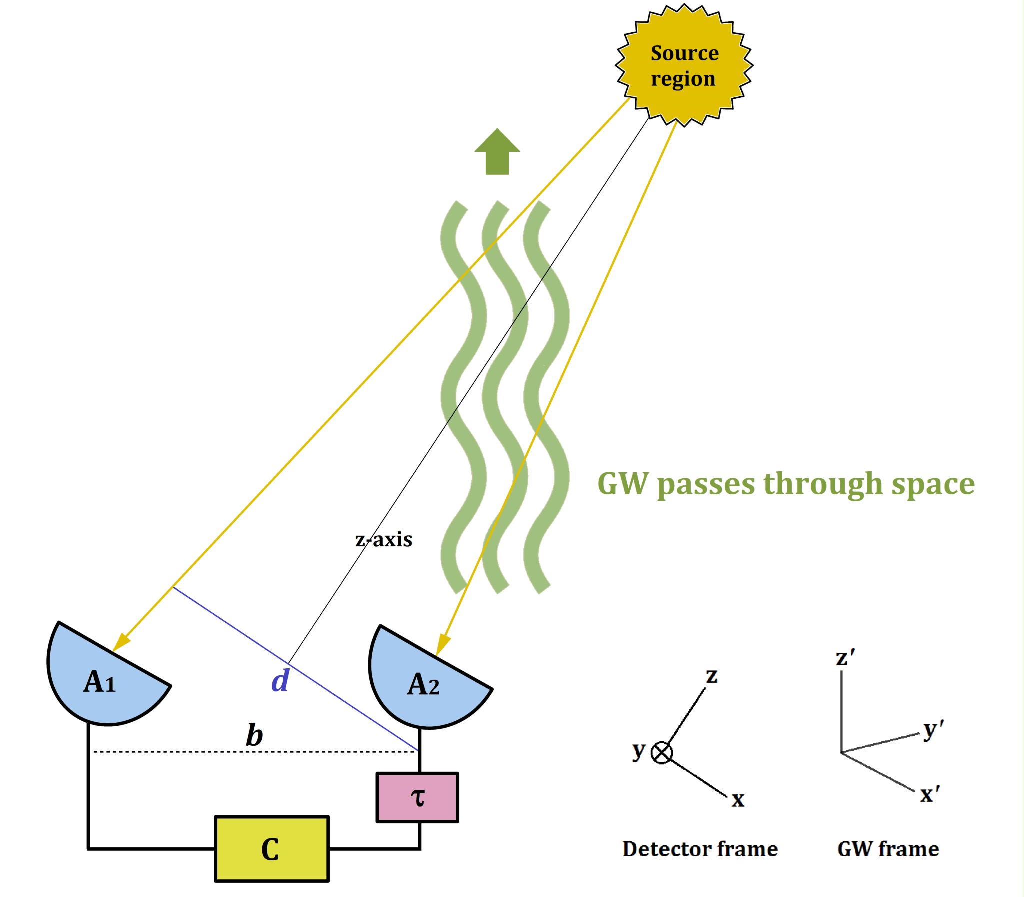
Amplitude interferometry for detection of gravitational waves

Dong-Hoon Kim and Sascha Trippe
Department of Physics and Astronomy, Seoul National University, Seoul 08826, Korea; ki13130@gmail.com

Abstract

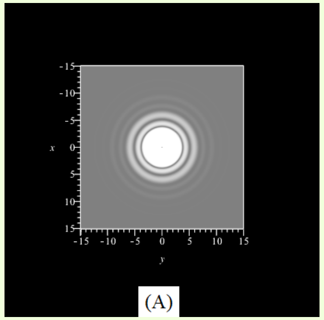
A novel method to detect gravitational waves is proposed, based on *amplitude interferometry* rather than conventional Michelson-type interferometry. In this proposal, electromagnetic waves such as light from a distant star and infalling radiation from the Cosmic Microwave Background are used instead of laser light. Electromagnetic radiation undergoes a perturbation as gravitational waves pass through its background. By means of an intensity interferometer, two beams of such perturbed radiation can be collected and converted into electronic signals, which are then combined by a correlator. The resulting interference pattern will provide the properties of the perturbed radiation, in which effects of gravitational waves are encoded: tiny variations in the fringe pattern and visibility. A *residual* is computed for the cumulative variations over a considerable time interval, from which the gravitational-wave sensitivity curves are obtained.

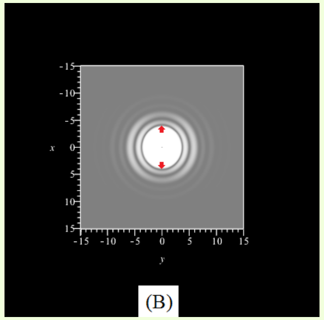
Basic ideas

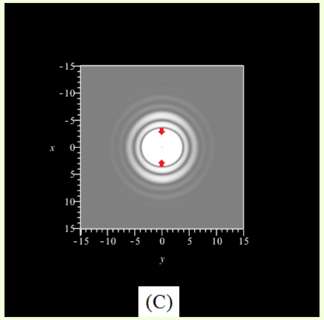


A layout of observation via *intensity interferometry*: Two antennas A_1 and A_2 located at a distance b observe a target. Each antenna observes an intensity given by a superposition of EMWs emitted from multiple point sources within the source region. At each antenna, the intensity is recorded and converted into an electronic signal. The signals are combined by a correlator C. Optical path differences are compensated by an electronic delay in one of the interferometer arms, *i.e.* $d = c\tau$. However, as GWs pass through our space, EMW fields undergo a perturbation, which changes the intensity of the fields and then the electronic signals to be fed into the correlator. The net perturbation of the correlated signals is analyzed to identify GW effects encoded in it.

The fringe pattern changes due to the GW effects.







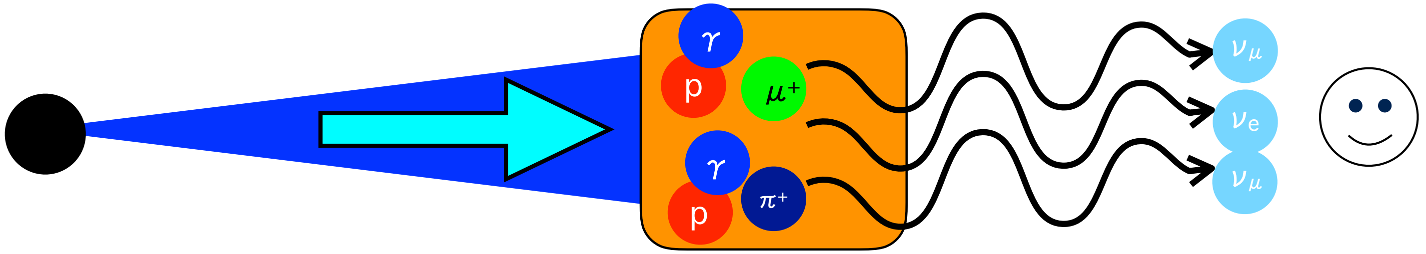
#18

High-energy Neutrinos from Neutron Star Mergers

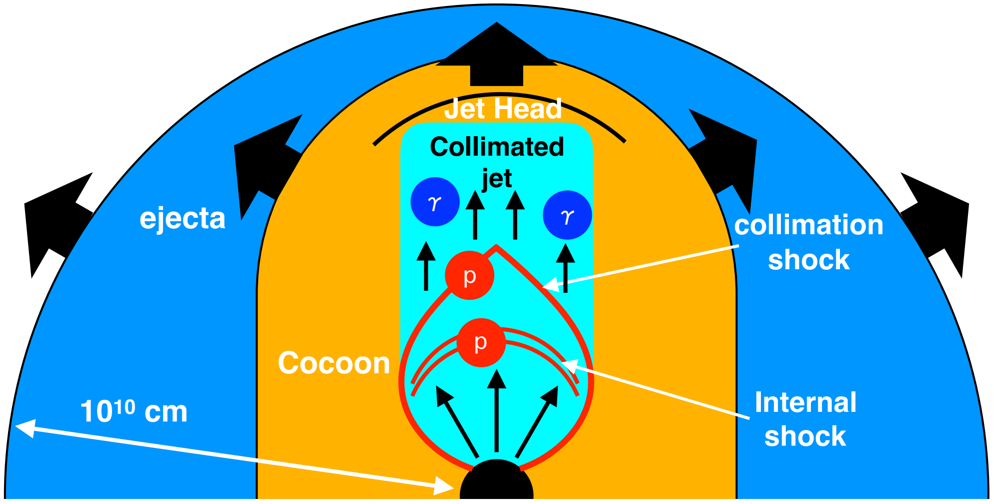
Shigeo S. Kimura

Tohoku University
(JSPS Research Fellow)

References
1) SSK, Murase, Meszaros, Kiuchi, 2017, ApJL, 848, L4
2) SSK, Murase, Bartos, Ioka et al. 2018, PRD, 98, 043020



Collaborators
Peter Meszaros, Kohta Murase (Penns State)
Kunihito Ioka, Kenta Kiuchi (Kyoto University)
Imre Bartos (University of Florida)
Ik Siong Heng (University of Glasgow)



Neutrino Detection Probability Coincident with Graviational Waves

NS–NS ($\Delta T = 10$ years)	IC (all)	Gen2 (all)
EE-mod-dist-A	0.11–0.25	0.37–0.69
EE-mod-dist-B	0.16–0.35	0.44–0.77
EE-opt-dist-A	0.76–0.97	0.98–1.00
EE-opt-dist-B	0.65–0.93	0.93–1.00

Multi-messenger detection of GW+ν is possible!!

GW+neutrino detection rate [yr^{-1}]		
model	IceCube (up+hor+down)	Gen2 (up+hor)
A (Optimistic)	0.38	1.2
B (Moderate)	0.024	0.091

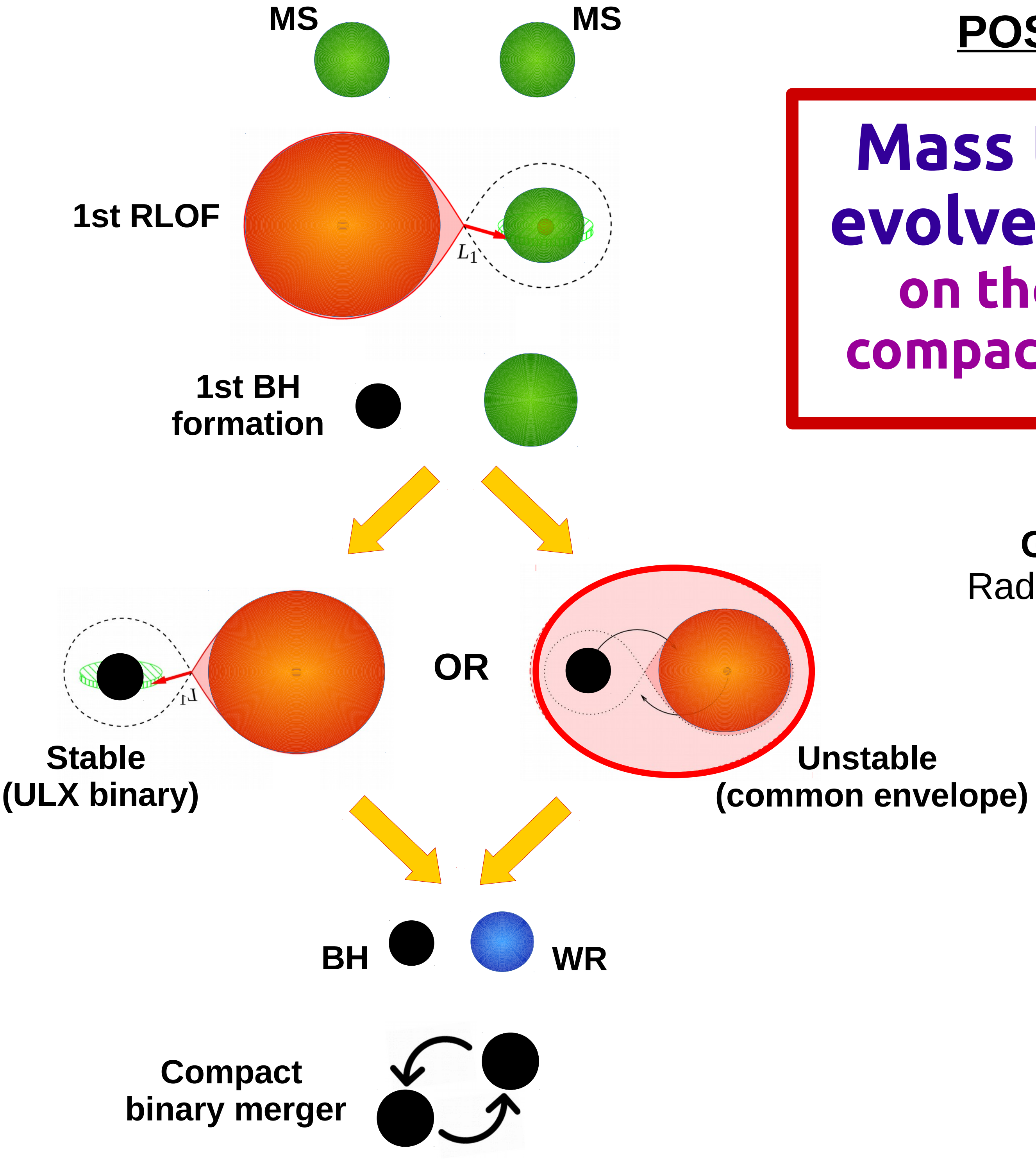
#19

#20

POSTER No. 20

Mass transfer from evolved supergiants:
on the path towards compact binary mergers

Jakub Klencki
Gijs Nelemans, Alina Istrate
Radboud University, Netherlands
j.klencki@astro.ru.nl



MS

MS

1st RLOF

1st BH
formation

OR

Stable
(ULX binary)

Unstable
(common envelope)

BH

WR

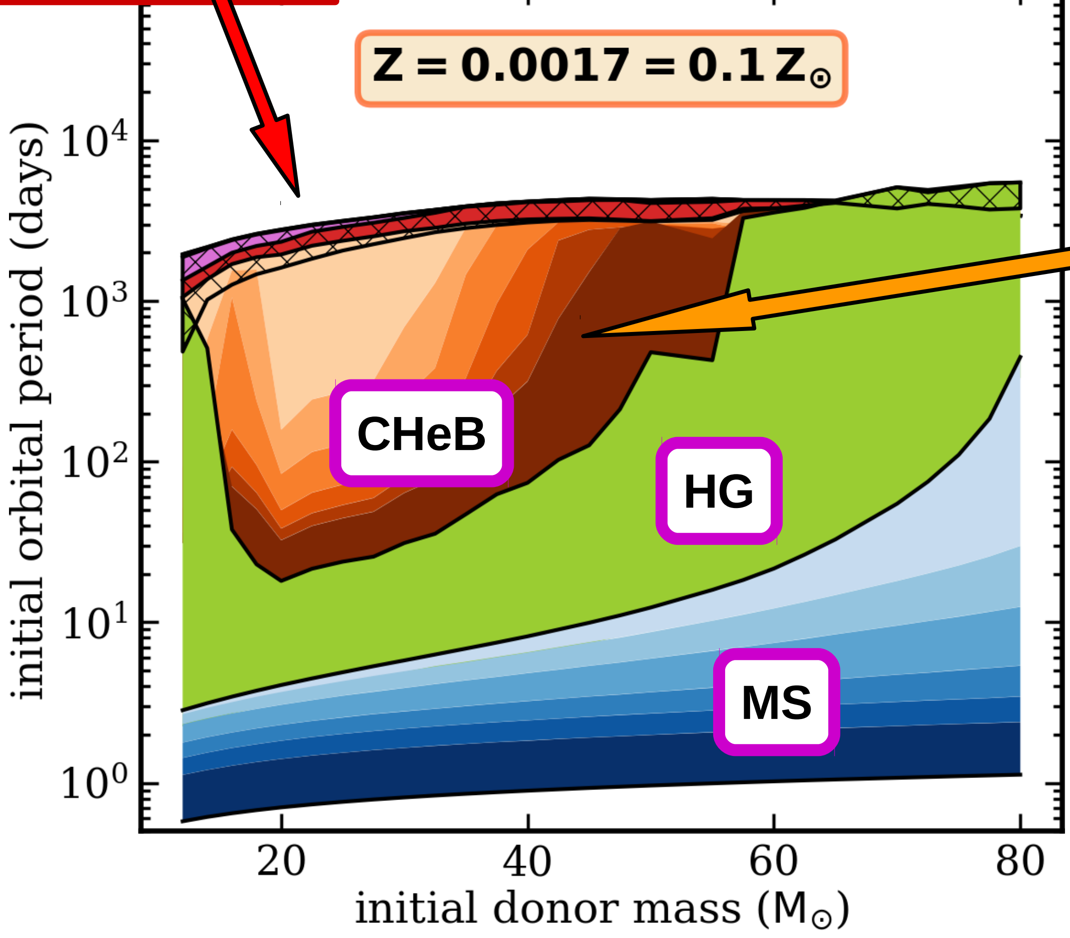
Compact
binary merger

MESA

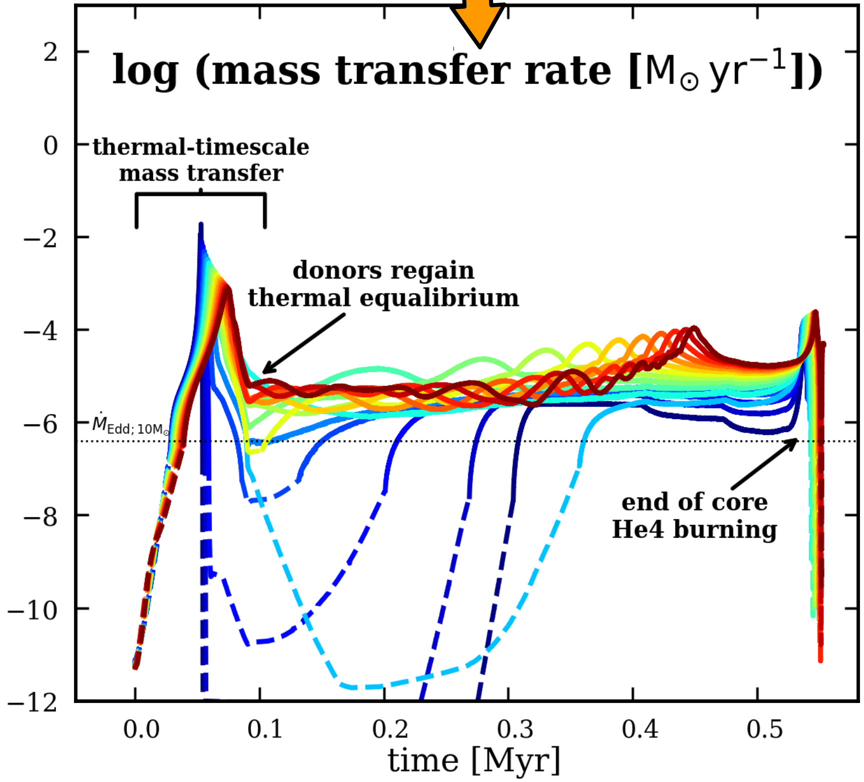
POSTER No. 20

Jakub Klencki
Radboud University, Netherlands

Very few convective donors (~1000 yr before CC!)



Stable (q ~ 5!) long-lasting Super-Eddington mass transfer (more ULXs at low Z)



MESA

#21

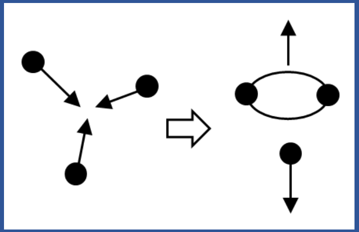
Formation of binary black holes in open clusters as gravitational wave sources

Jun Kumamoto (The University of Tokyo)
Collaborator : M. S. Fujii
A. Tanikawa

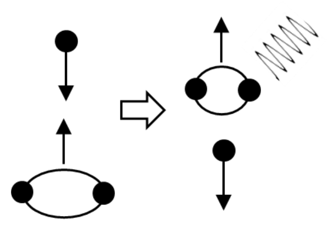
Gravitational wave (GW) observation show that
$\sim 10 M_\odot$ binary black holes commonly exist in the universe.

↓

Formation Scenario : three-body encounter in dense cluster



Binary Formation



Binary Evolution

In the Case of Open Cluster
- a few black holes
- shallower potential

⇒ It seem to be difficult to make hard binary black hole…?

Our Simulations :

We performed a series of direct N-body simulations with a $\sim 10^{3-4} M_\odot$

Our Results :
- In open cluster, binary black holes can be formed.
- The number of BBH mergers is 20-50 % of that for globular clusters.

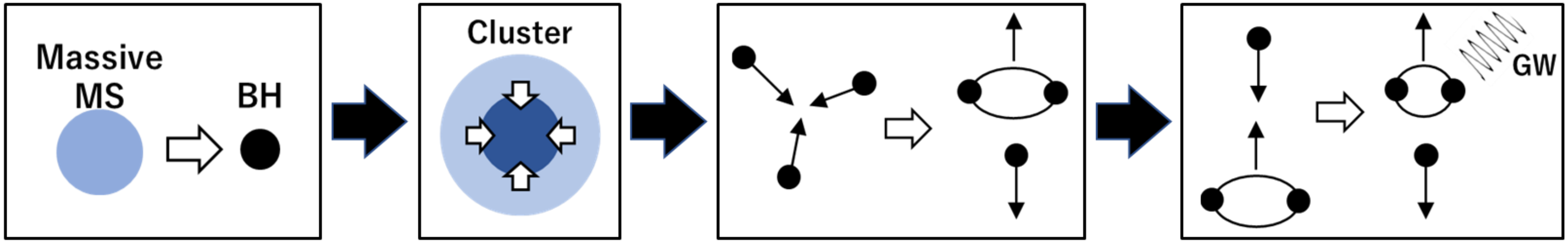
Thus, open clusters can be a dominant formation site of hard binary black holes.

Formation of binary black holes in open clusters as gravitational wave sources

difference of formation processes of merging BBH in globular cluster and open cluster

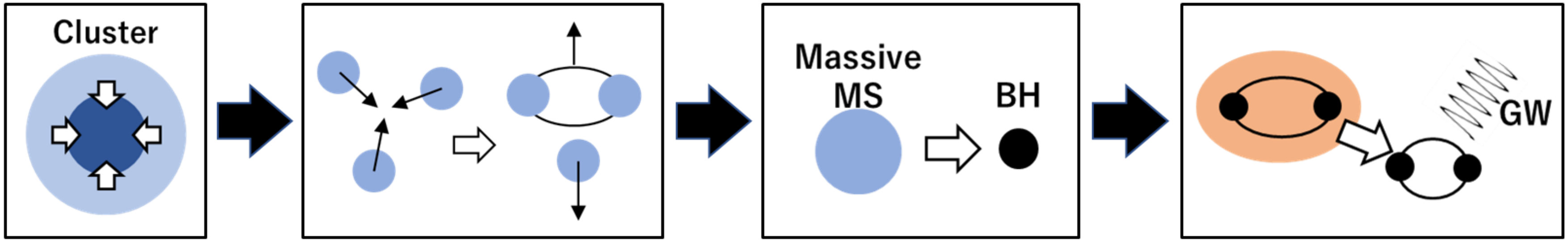
- core-collapse time : $t_{\mathrm{cc}} \sim 500 \, \frac{N}{\log(0.4N)} \left(\frac{\rho_{\mathrm{hm}}}{10^4 M_\odot \mathrm{pc}^{-3}} \right)^{-\frac{1}{2}} \mathrm{yr}$
- For stars with a mass of $100\ M_\odot$, the main-sequence life-time : $\sim 3\ \mathrm{Myr}$

Case of Globular Cluster$(10^{5-6}\ M_\odot)$ Life Time of Massive Main-Sequence < Core-Collapse Time



Black Hole Formation → Core-Collapse → Three-Body Encounter Binary Formation → Three-Body Interaction Merging BBH Formation

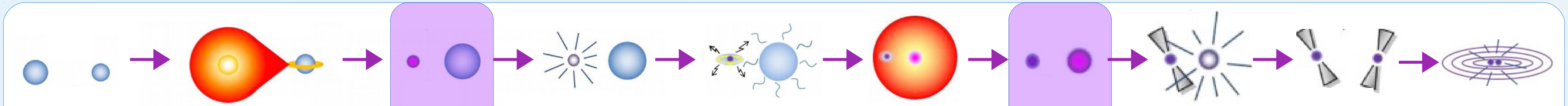
Case of Open Cluster$(10^{3-4}\ M_\odot)$ Core-Collapse Time < Life Time of Massive Main-Sequence



Core-Collapse → Three-Body Encounter Binary Formation → Black Hole Formation → Common Envelope Merging BBH Formation

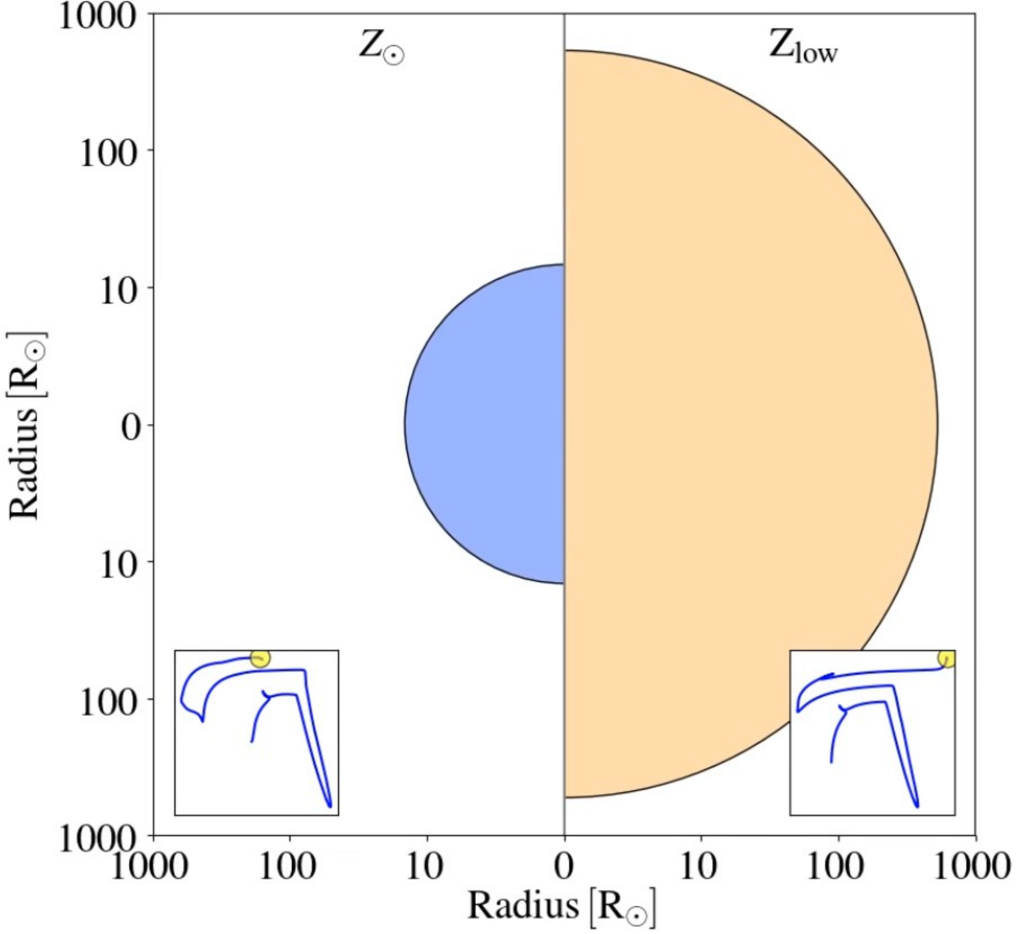
#22

The size of stars stripped in binaries...



Adapted from Figure 1. in Tauris et al. 2017

MESA
Modules for Experiments in Stellar Astrophysics



Stars stripped in binaries can expand to giant sizes, depending on how much hydrogen they retain.

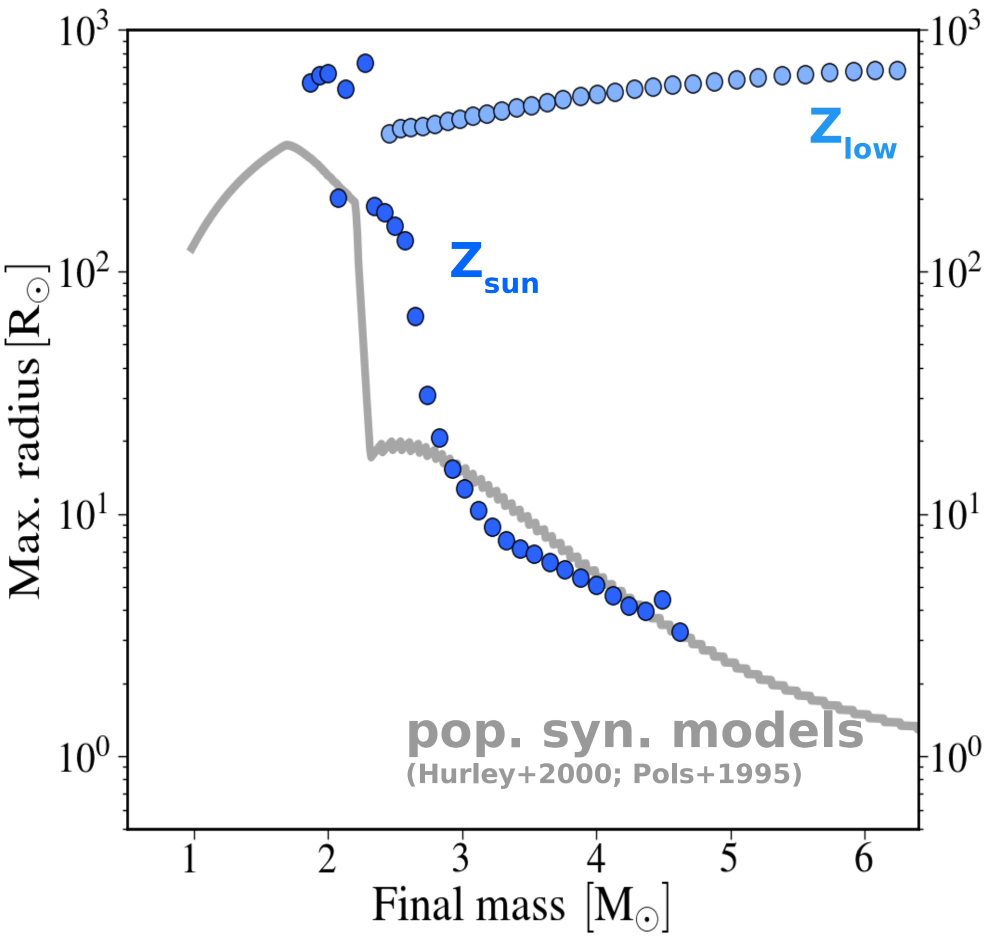
→ 10 – 100 $R_{\rm sun}$ at $Z_{\rm sun}$

→ > 400 $R_{\rm sun}$ at $Z_{\rm low}$

Poster 22

… and its impact on GW progenitors

Laplace et al. in prep.



More systems will interact again then population synthesis models assume!

→ 2 – 3 x more at Z_{sun}

→ 2 – 30 x more at Z_{low}

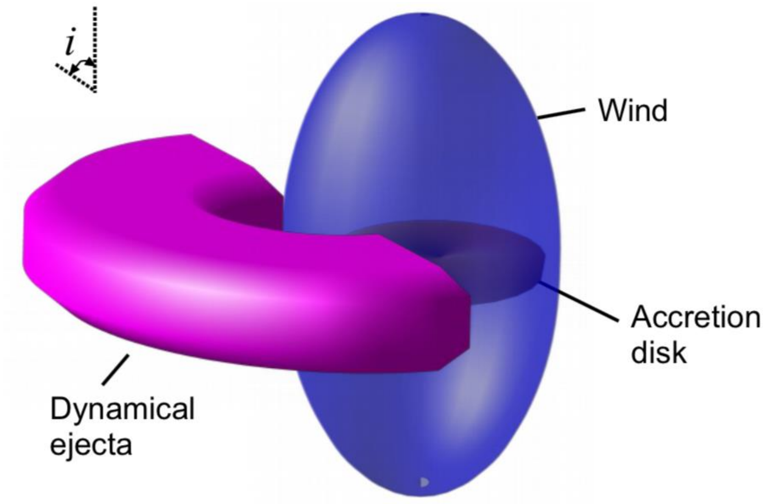
Poster 22

#23

Polarization of Kilonova Emission from a Black Hole-Neutron Star Merger

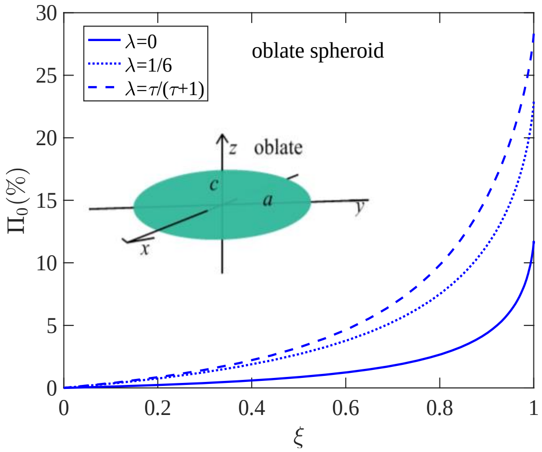
Yan Li & Rong-Feng Shen
liyan287@mail2.sysu.edu.cn , shenrf3@mail.sysu.edu.cn
Sun Yat-sen University

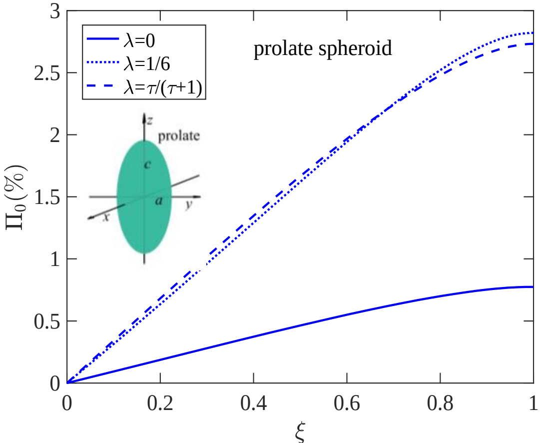
Ejecta components in a BH-NS merger



Note: a small amount of free neutrons (not shown here) may survive in the fastest, top layer of either the tidal ejecta or the disk wind (Metzger et al. 2015).

Theoretical polarization calculation for oblate/prolate spheroid





Polarization of Kilonova Emission from a Black Hole-Neutron Star Merger *(Li & Shen, ApJ, 2019)*

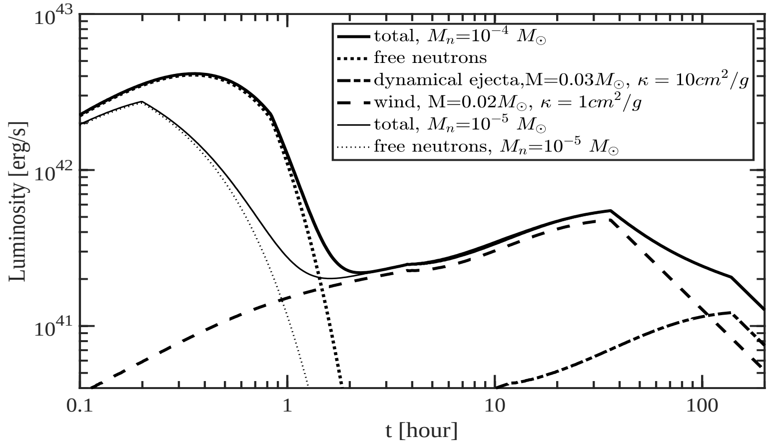
General consideration for the polarization of kilonova emission from a BH-NS merger

The net polarization from an ellipsoidal shape of photosphere can be generally estimated from the following equation

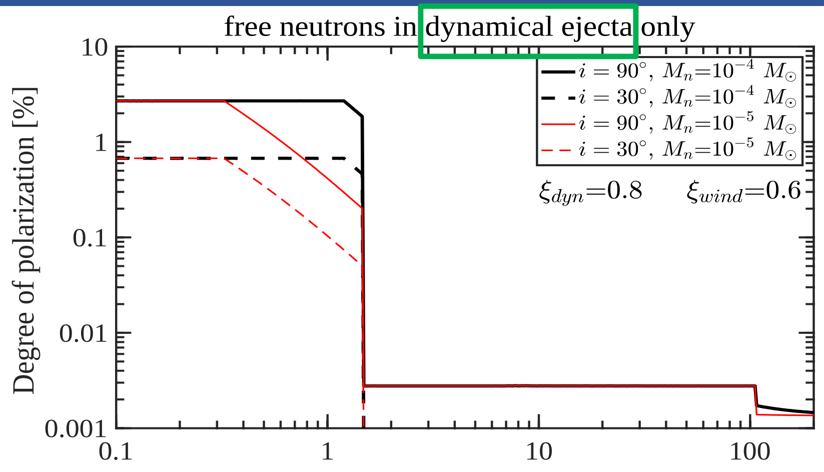
$$\Pi_{net} = \Pi_0 \tau_{es} sin^2 i$$

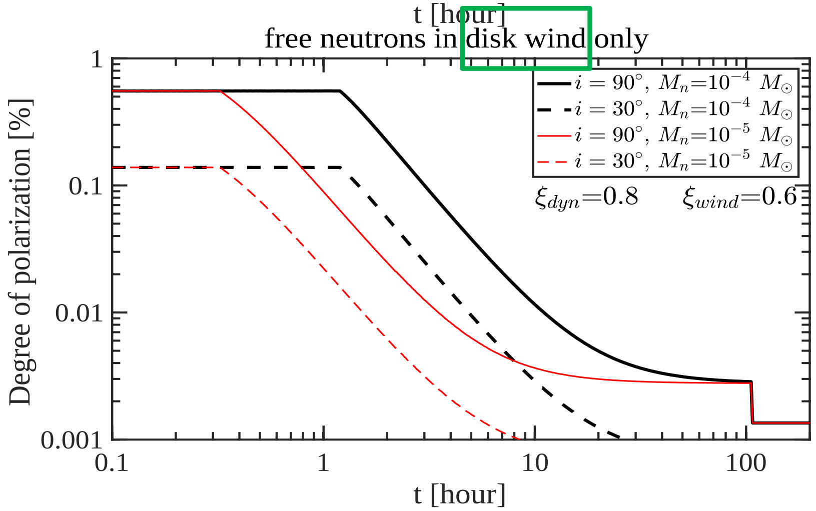
where Π_0 is the maximum degree of polarization that a given shape of ellipsoid (here, i.e., oblate or prolate) could ever obtain, Π_{net} reaches its maximum value only when $\tau_{es} = 1$ and i = 90°.

Results



The bolometric luminosity light curve for a kilonova from a BH-NS merger, assuming free neutrons survived in the outmost layers of dynamical ejecta.





The polarization of the observed emission.

Initially, the photosphere is located in the free neutron layer and $\tau_{es} \simeq 1$ resulting in the polarization $\Pi_{net} \approx \Pi_0$. As the photosphere recedes to the r-process element-rich ejecta ($\nu < v_n$), τ_{es} drops quickly, resulting in the significant decrease of the polarization degree.

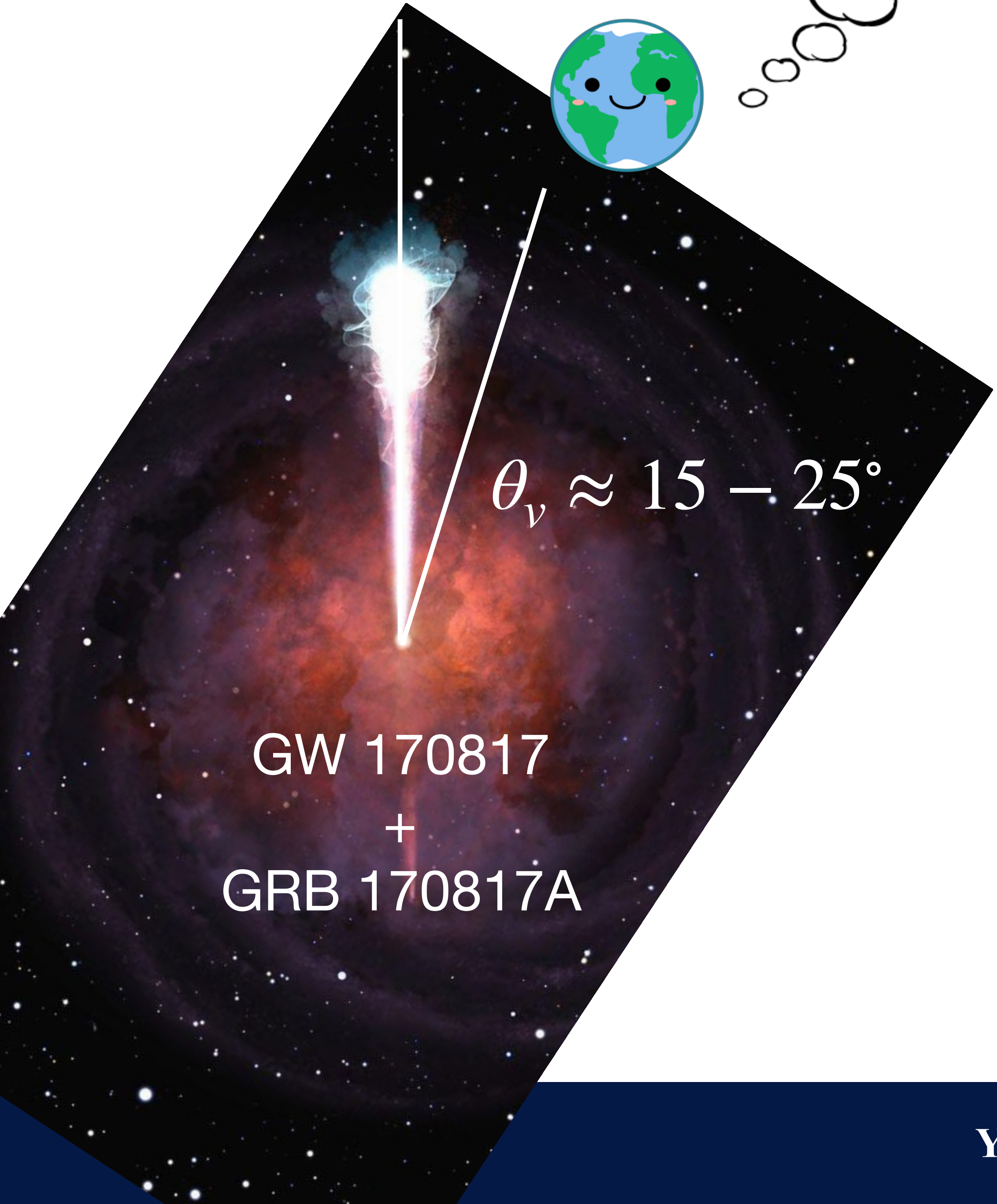
#24

VHE afterglow of BNS mergers

Haoxiang, LIN
Tomonori, TOTANI
(UTokyo)

- **First GW + GRB!**

Observable at **large viewing angle**!

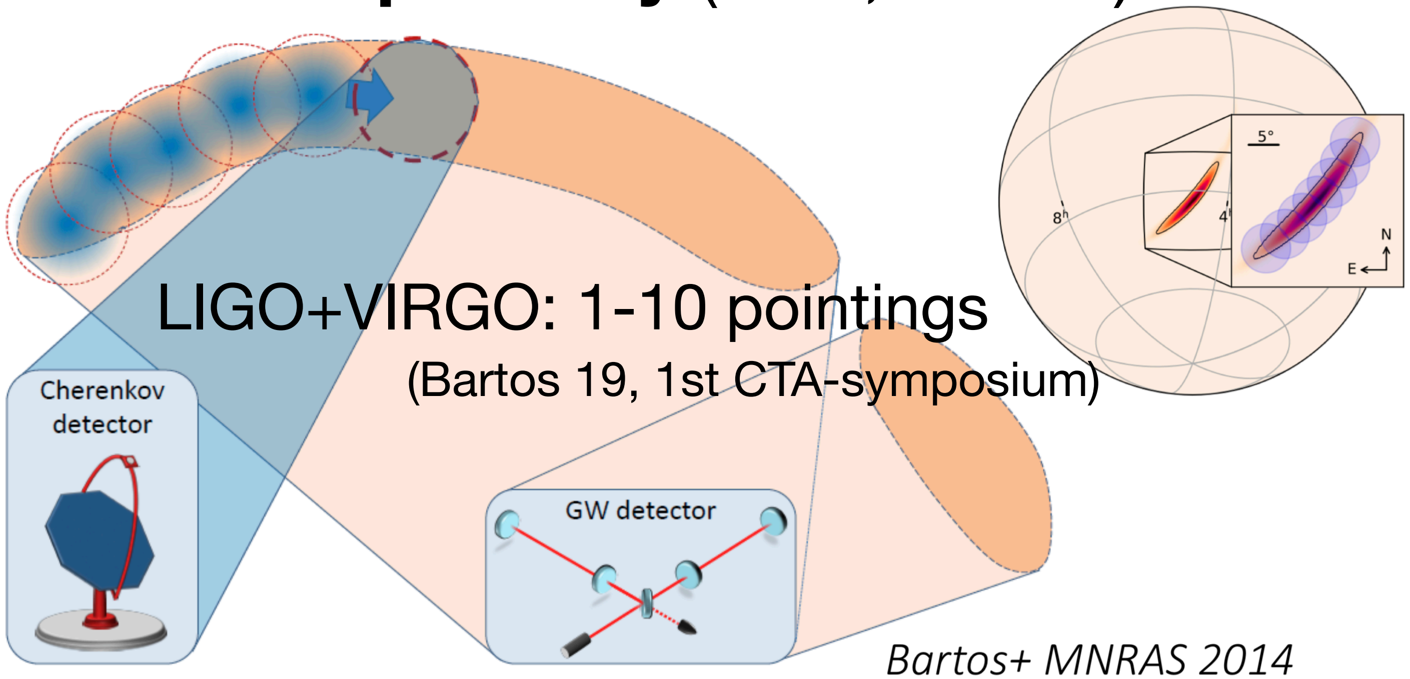


- **3 Very-High-Energy (VHE,>100GeV) GRBs** reported this year!

(190114C, 180720B, 190829A)

GW+VHE provides powerful probe of particle acceleration theory/cosmic ray origin!

- Efficient VHE search with **Cherenkov Telescope Array** (**CTA**, ~2022)

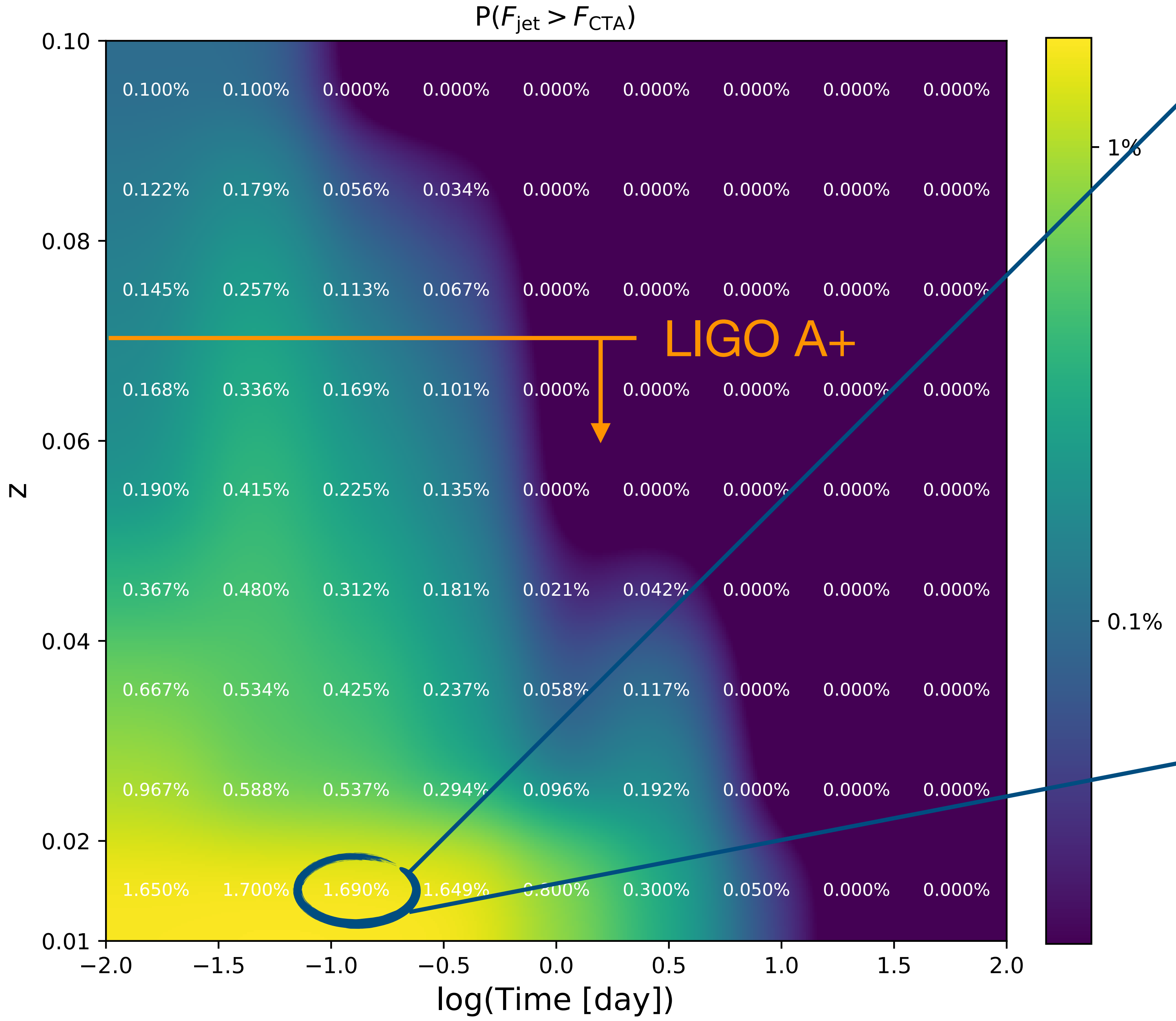


LIGO+VIRGO: 1-10 pointings
(Bartos 19, 1st CTA-symposium)

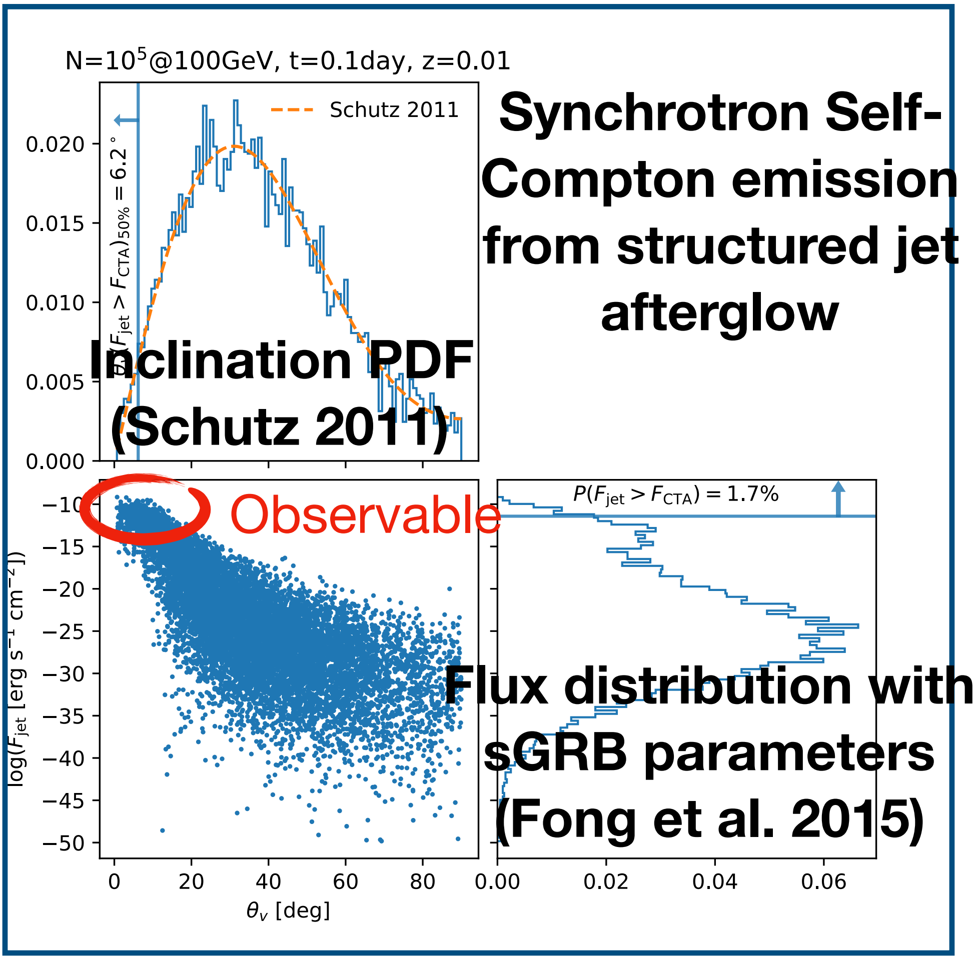
Bartos+ MNRAS 2014

Will CTA see BNS mergers?

Prob($t_{\rm obs}, z$) Map



LIGO A+



Synchrotron Self-Compton emission from structured jet afterglow

Inclination PDF (Schutz 2011)

Observable

Flux distribution with sGRB parameters (Fong et al. 2015)

Within LIGO A+ horizon (<325 Mpc)

Early CTA observation (e.g. <5 hr)

$$P(\mathrm{CTA}\,|\,\mathrm{GW}) \sim 0.4\,\%$$

Prob. that CTA sees a BNS after GW trigger, under inclination distribution of BNS mergers detected by GW, at source redshift *z* and observed time $t_{\rm obs}$

Local $R_{\rm BNS}$ ~ 110–3840 $\mathrm{Gpc}^{-3}\,\mathrm{yr}^{-1}$ (O1+O2)

0.1–3 GW+CTA detections/year*

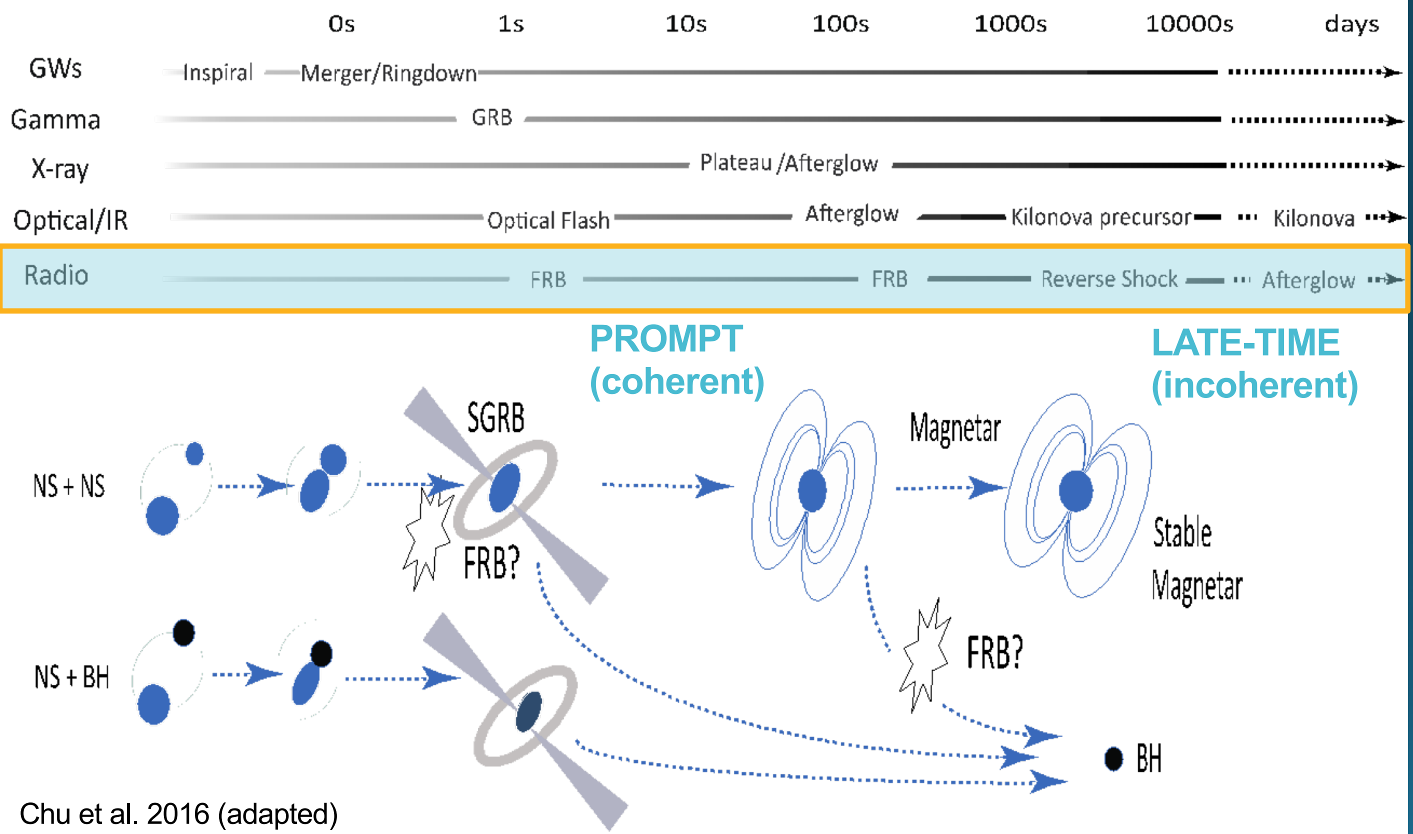
*CTA duty cycle will reduce the rate by a factor of ~5–10 (Bartos 19, 1st CTA symposium)

#25

#26

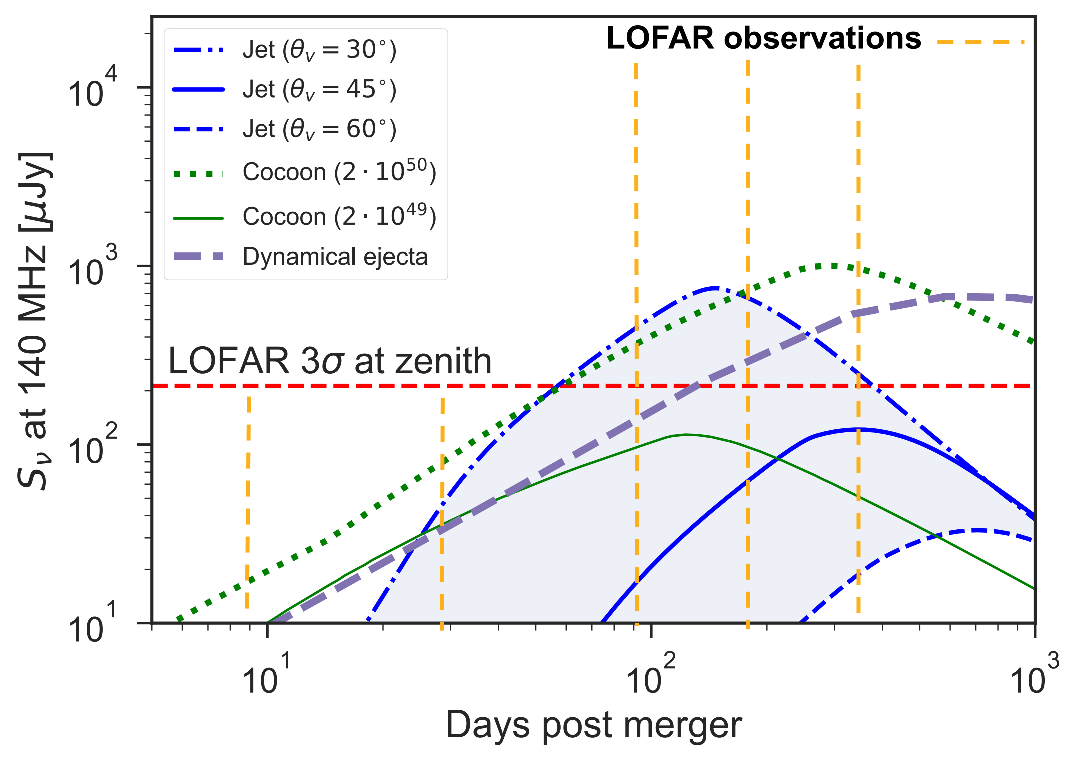
Observing radio signatures of compact mergers and GRBs with LOFAR (poster 26)

Kelly Gourdji
University of Amsterdam
Poster 26



Chu et al. 2016 (adapted)

Probing radio afterglow models

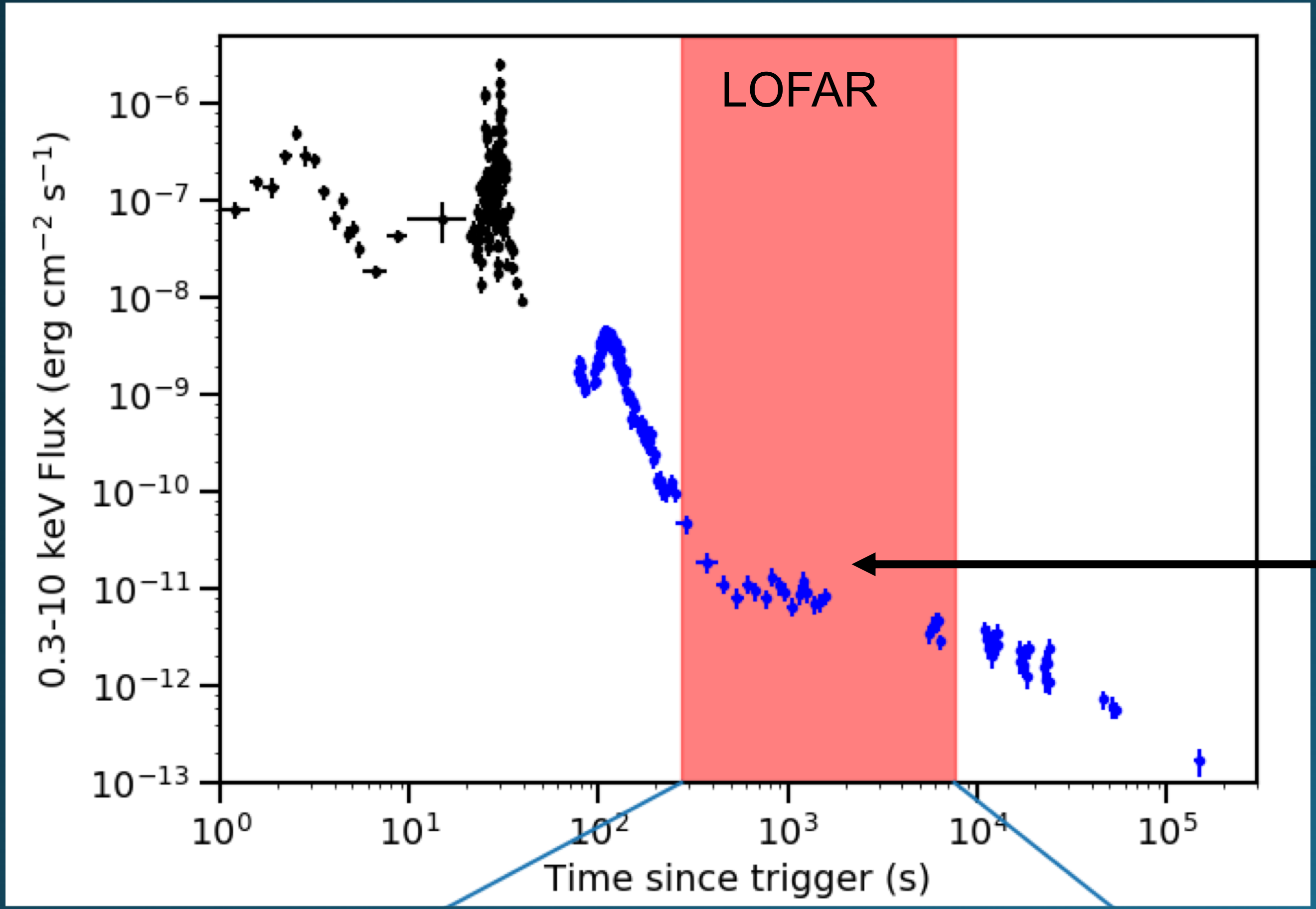


Broderick, Shimwell, Gourdji et al. submitted

Observing radio signatures of compact mergers and GRBs with LOFAR (poster 26)

Kelly Gourdji
University of Amsterdam
Poster 26

Prompt LOFAR observations of long GRB 180706A



Rowlinson, Gourdji et al. 2019

X-ray plateau from magnetar remnant?

LOFAR constraints on:

- FRB-like emission
- persistent emission