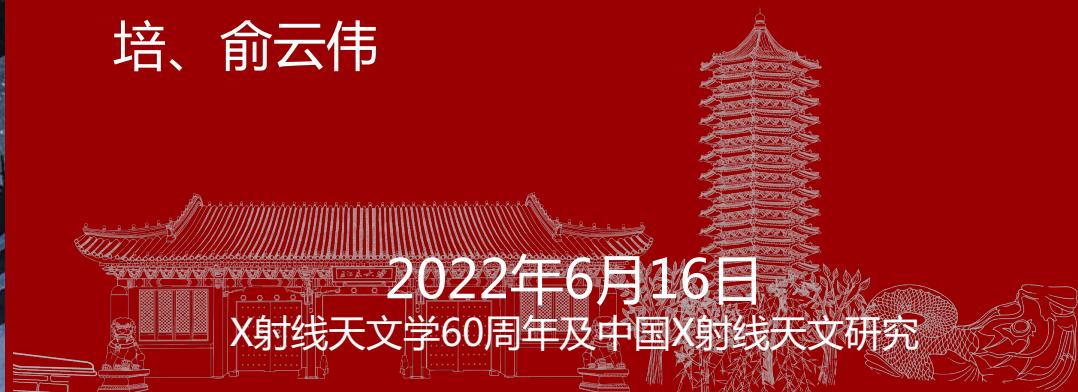


# 活动星系核吸积 盘中暂现源的多 信使辐射

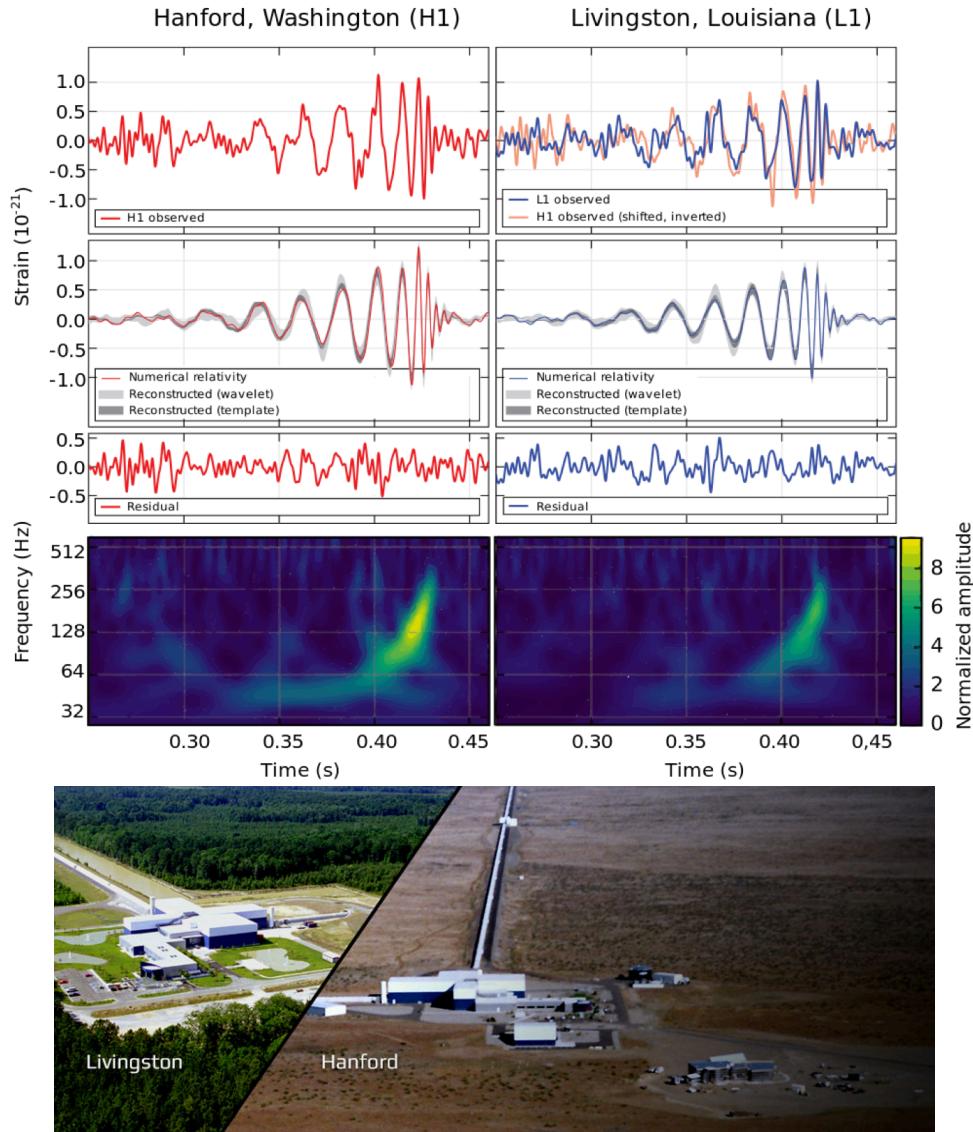
报告人：朱锦平

导师：张冰、黎卓

合作者：高鹤、刘良端、王凯、杨元  
培、俞云伟

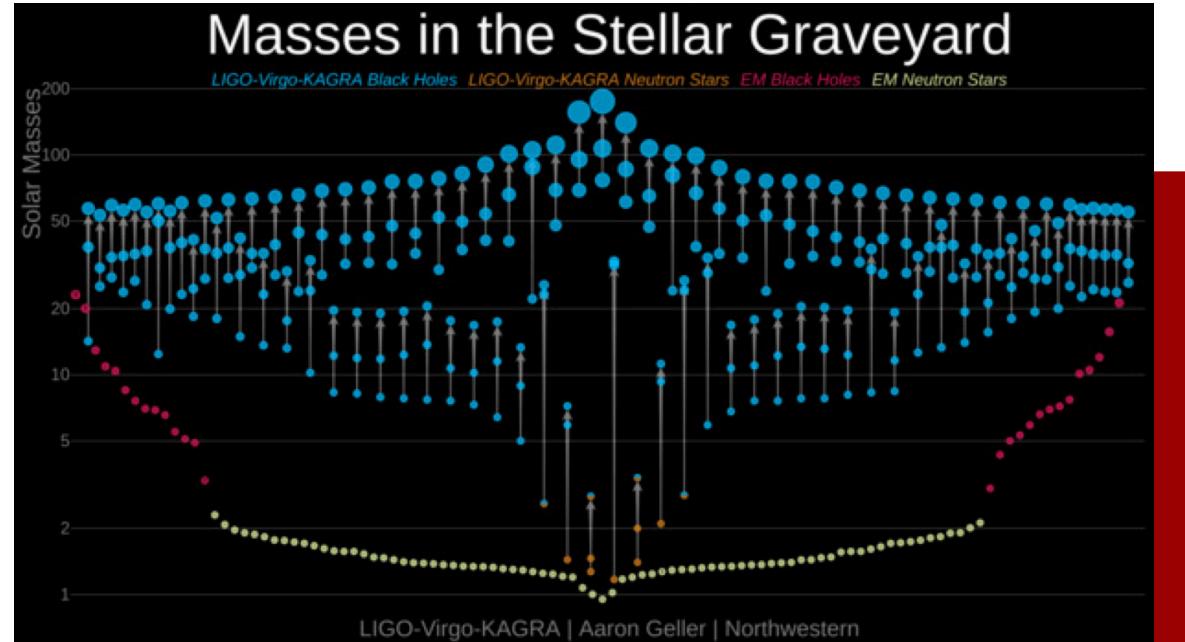


# Introduction

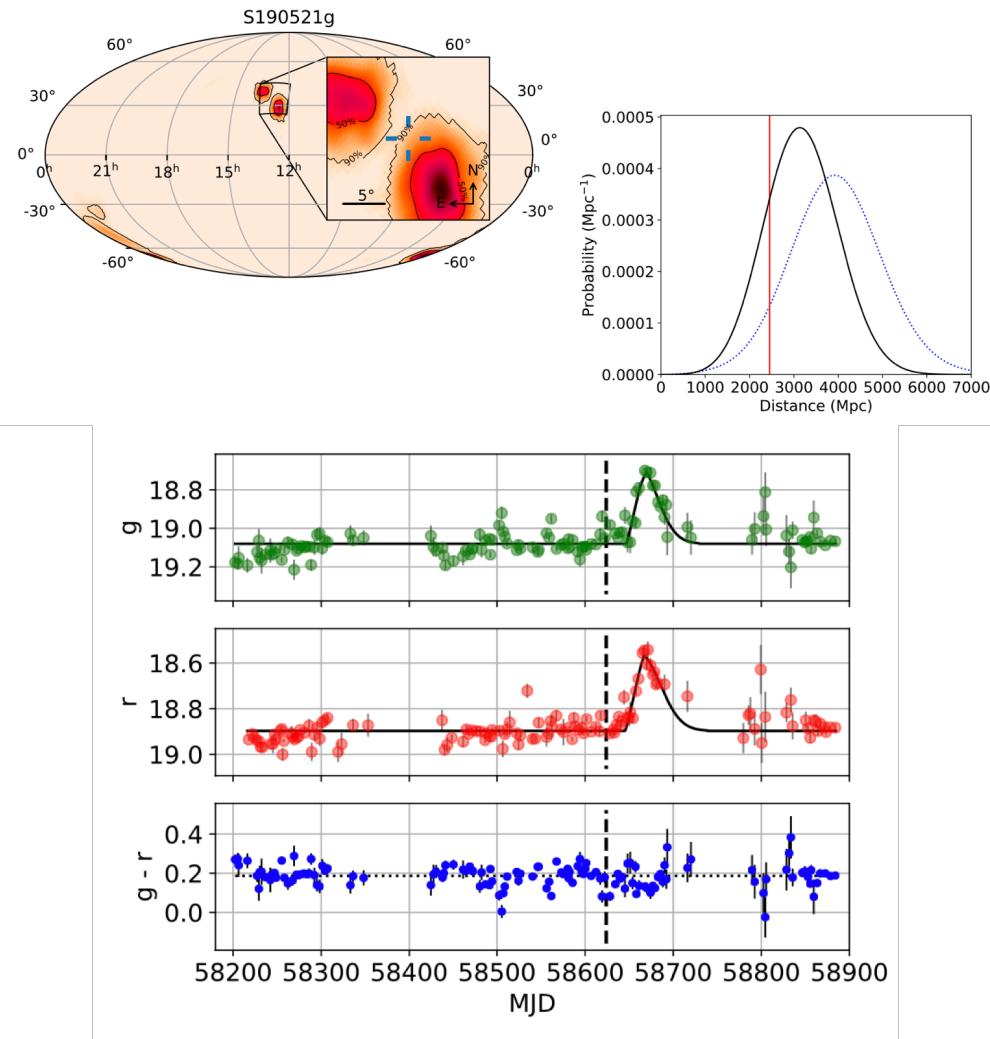


## ● GW150914

- The first GW from compact object coalescence
- The first GW from binary black hole merger



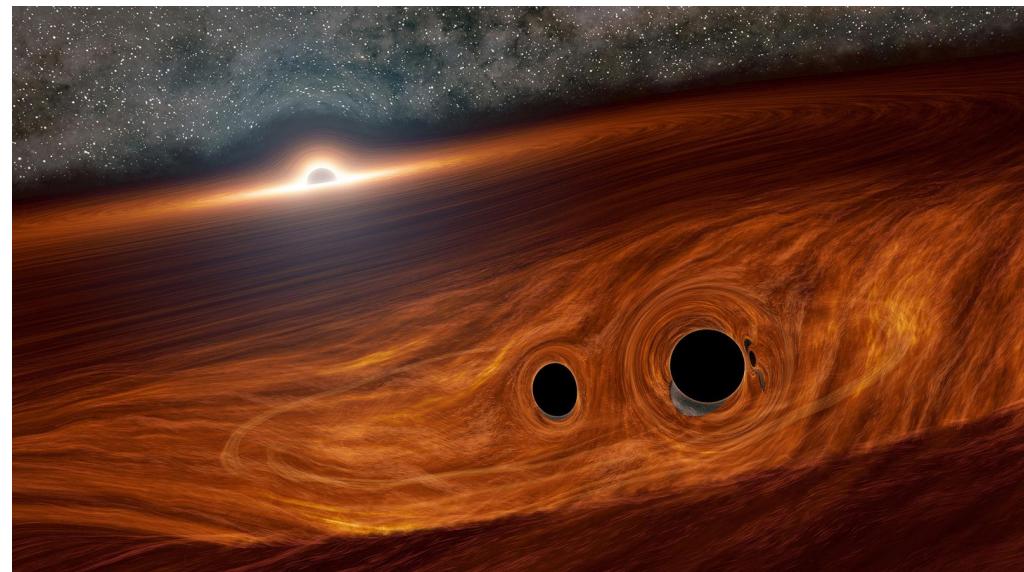
# Introduction



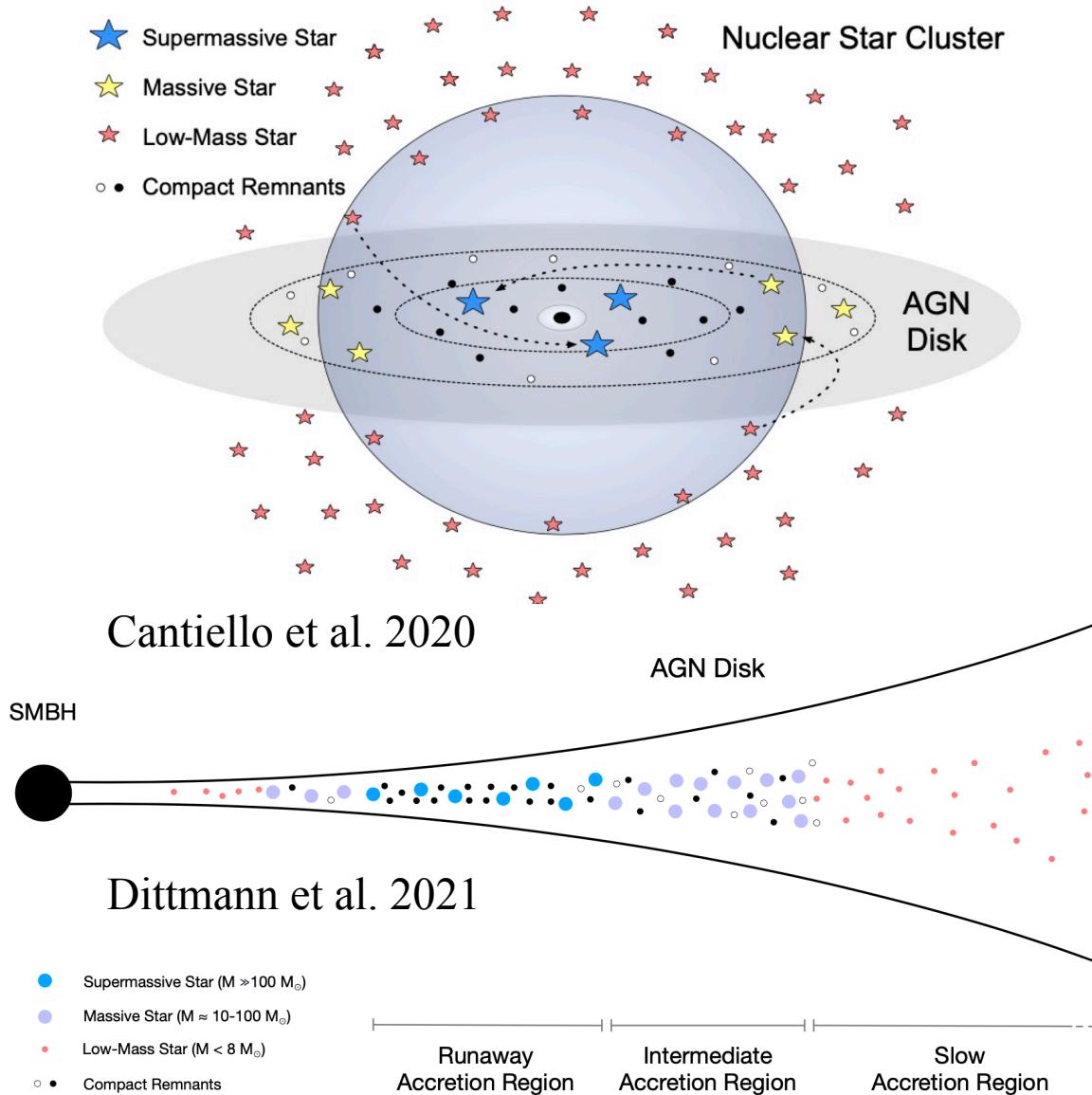
Graham et al. (2020)

## ● GW190521 & EM counterpart

- Intermediate-mass BH
- Binary black hole merger occurring in an AGN disk
- Potential EM counterpart



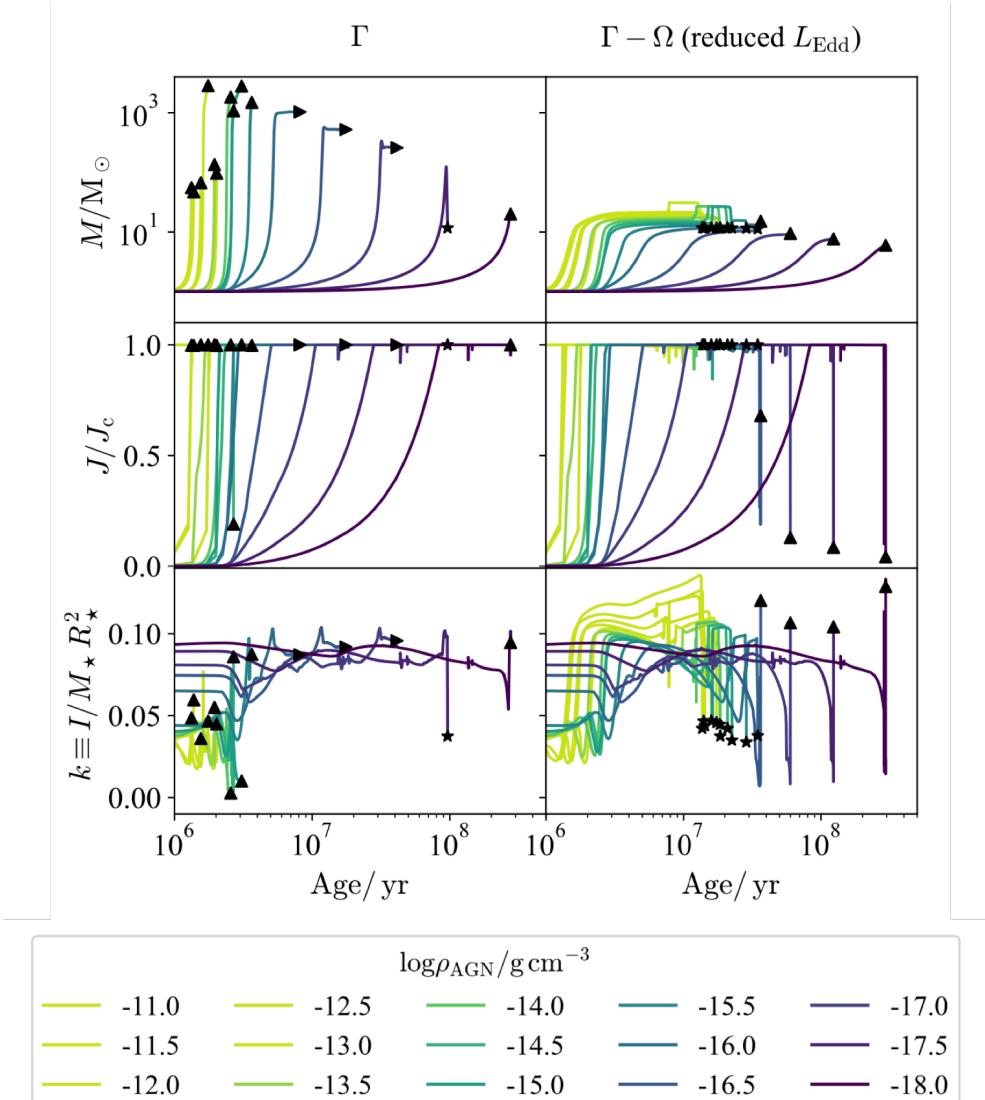
# Transients in AGN Disks



**Star and compact remnant formation in AGN disks:**

- Born in situ in an AGN accretion disk.
- Captured from the nuclear star cluster around the AGN.

# Transients in AGN Disks



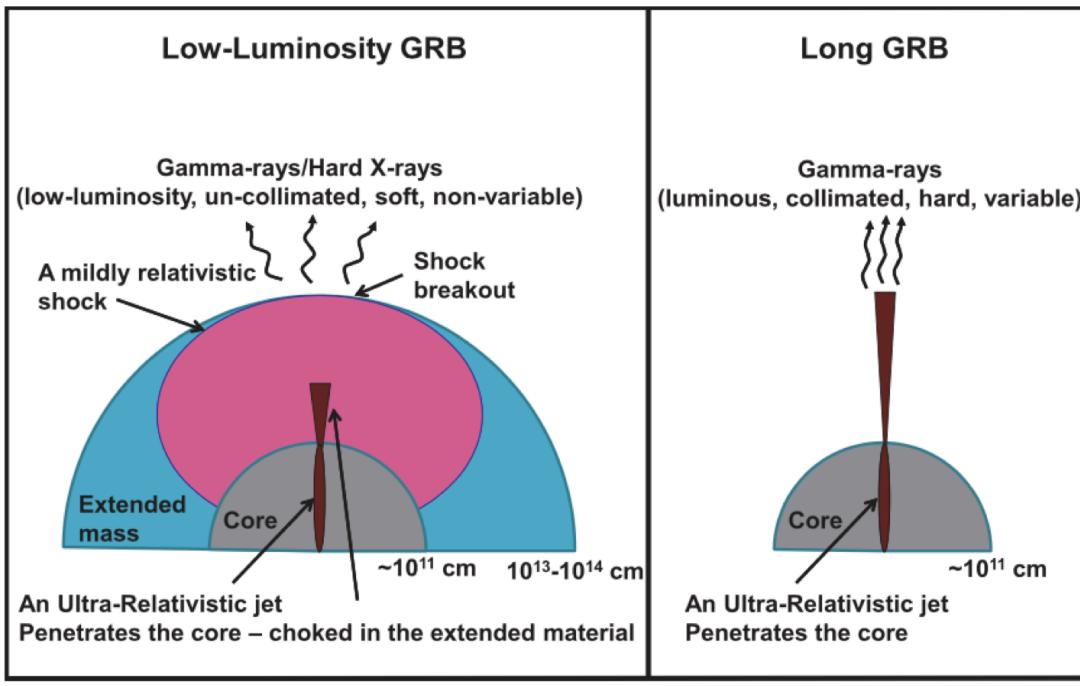
Jermyn et al. 2021

## Characteristics of AGN stars:

- Could even accrete up to masses over  $10^3 M_\odot$ .
- Undergo quasi-chemically homogeneous evolution.
- Spin up to critical rotation.
- Form compact helium/carbon/oxygen stars.
- Easily make LGRBs.

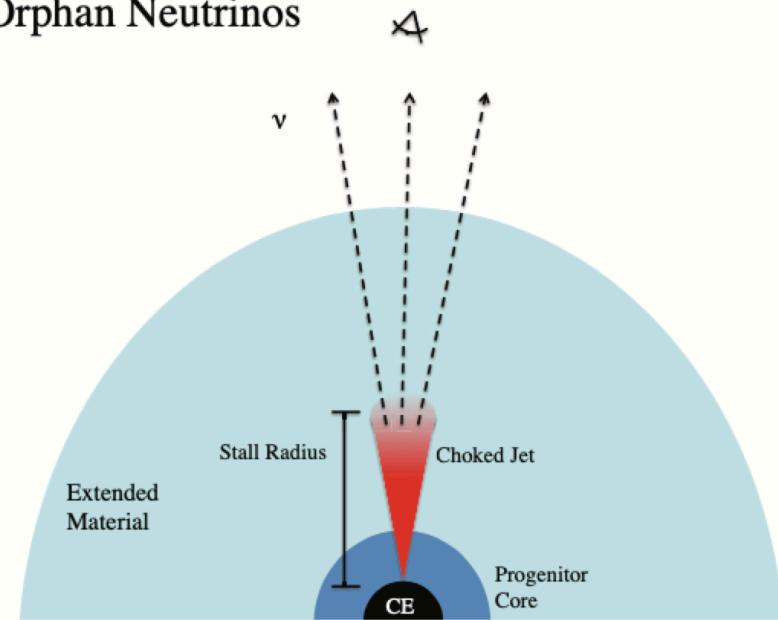
# Transients in AGN Disks

AGN neutron star mergers



Nakar 2015

Orphan Neutrinos



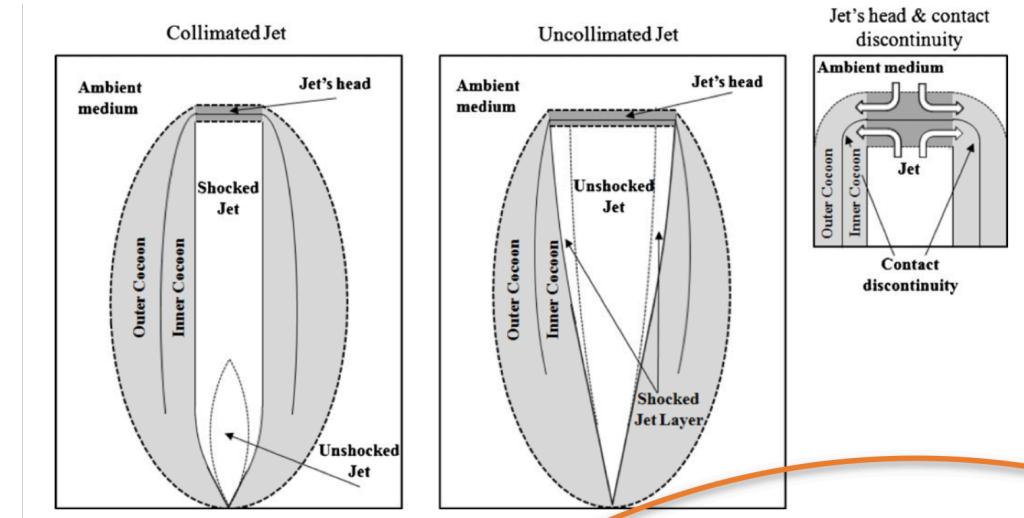
Senno et al. 2016

**Low-luminosity GRBs:**

LGRB jets could be choked by the envelope or the extended material as hidden sources of astrophysical high-energy neutrinos.

# Transients in AGN Disks

AGN neutron star mergers



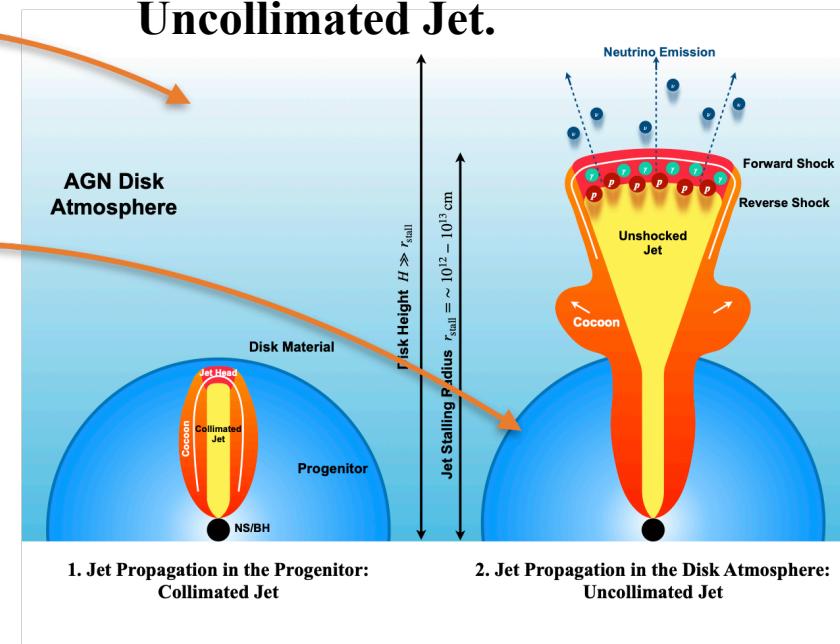
**Table 1**  
The System's Characteristics in the Collimated and Uncollimated Regimes

Parameter	Collimated Jet		Uncollimated Jet		
	Causal Head	Uncausal Head	Free Expansion		
$\tilde{L}$	$\tilde{L} < 1$	$1 \ll \tilde{L} < \theta_0^{-4/3}$	$\theta_0^{-4/3} < \tilde{L} \ll 4\theta_0^{-4}$	$4\theta_0^{-4} < \tilde{L} \ll 4\Gamma_j^4$	$\Gamma_j^4 \ll \tilde{L}$
$\beta_h$	$\tilde{L}^{1/2}$	1			
$\Gamma_h^2$	1	$\frac{1}{2}\tilde{L}^{1/2}$	$\frac{1}{2}\tilde{L}^{1/2}$		$\Gamma_j^2$
$\theta_j$	$\tilde{L}^{1/4}\theta_0^2$	$\tilde{L}^{3/4}\theta_0^2$		$\theta_0$	
$\Gamma_j^a$	$\Gamma_{j1} = \theta_0^{-1}$		$\Gamma_{j0}$		
$P_c$	$\tilde{L}\theta_0^2\rho_ac^2$		$\tilde{L}^{1/4}\theta_0\rho_ac^2$		$\Gamma_j\theta_0\rho_ac^2$
$\beta_c$	$\tilde{L}^{1/2}\theta_0$		$\tilde{L}^{1/8}\theta_0^{1/2}$	1	
$\eta$	1		$(\tilde{L}^{1/4}\theta_0)^{-1}$	$(\Gamma_{j0}\theta_0)^{-1}$	

Bromberg et al. 2011

Critical Parameter:  $\tilde{L} = \frac{L_j}{\Sigma_j \rho_a c^3}$

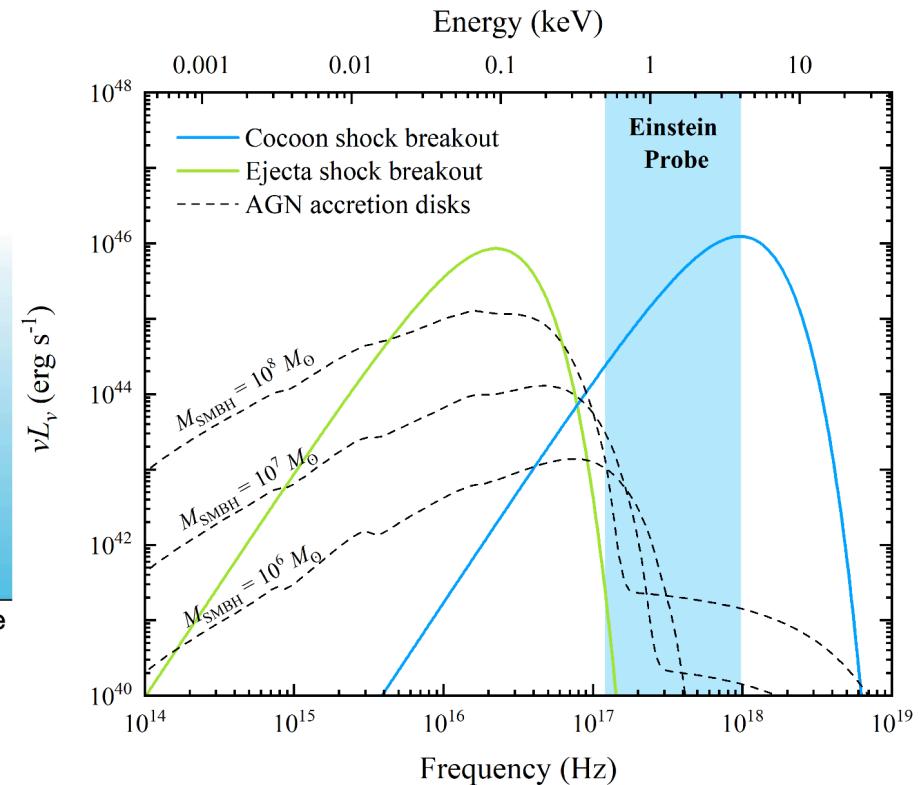
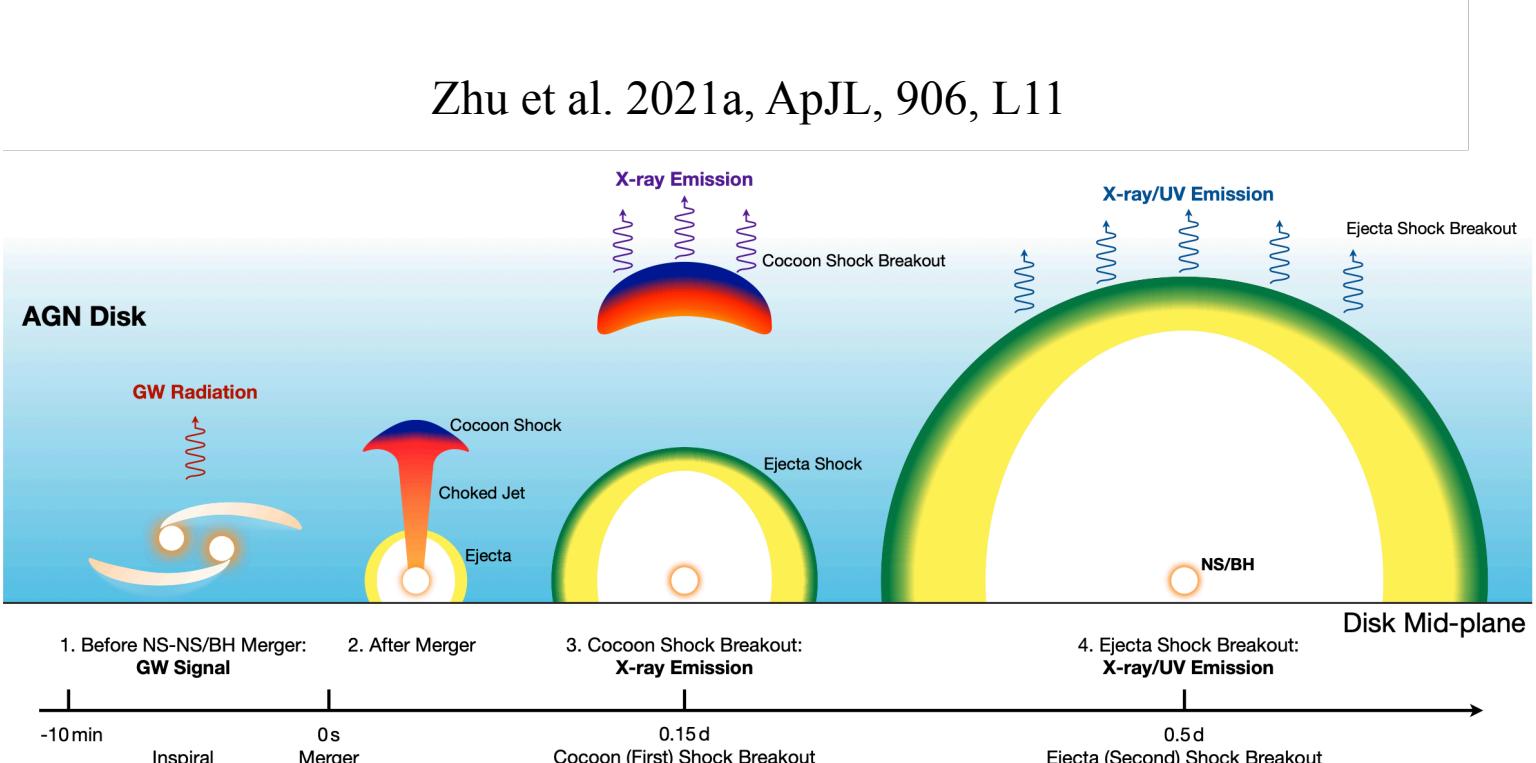
- **Jet Propagation in the Progenitor:**  
**Collimated Jet;**
- **Jet Propagation in the Disk Atmosphere:**  
**Uncollimated Jet.**



# Transients in AGN Disks

AGN neutron star mergers

Zhu et al. 2021a, ApJL, 906, L11

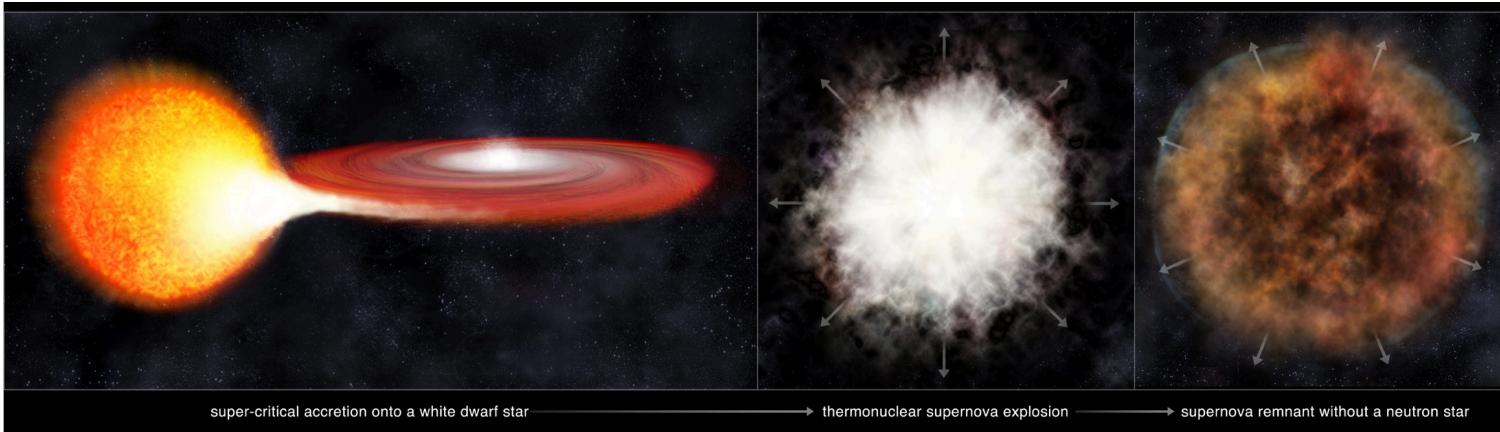


- **Cocoon (first) shock breakout: X-ray emission**
- **Ejecta (second) shock breakout: UV emission**
- **No observed kilonova and cocoon cooling emission**

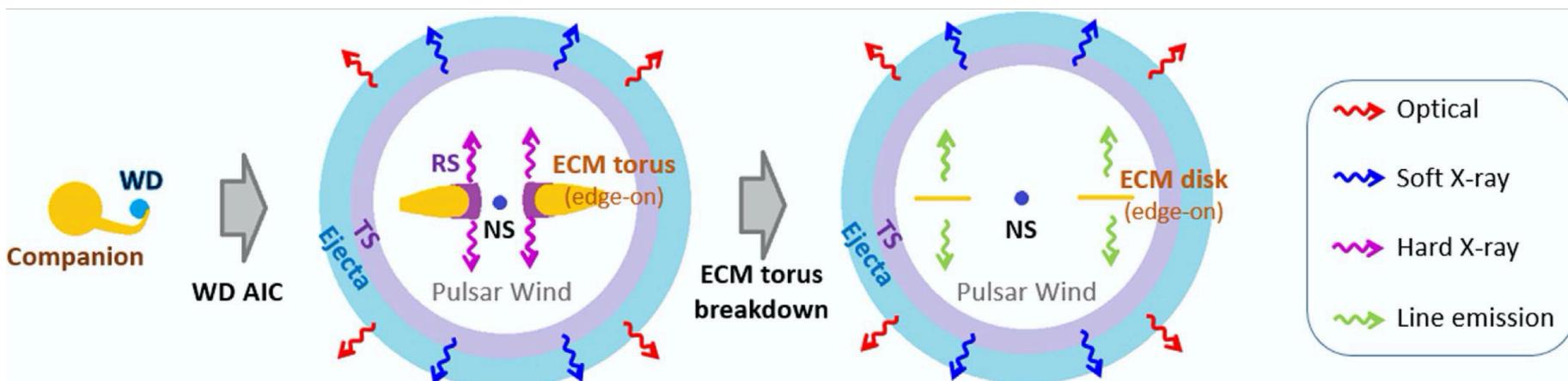
# Transients in AGN Disks

AGN AICs of WDs

- Runway Thermonuclear Emission: Type Ia supernovae

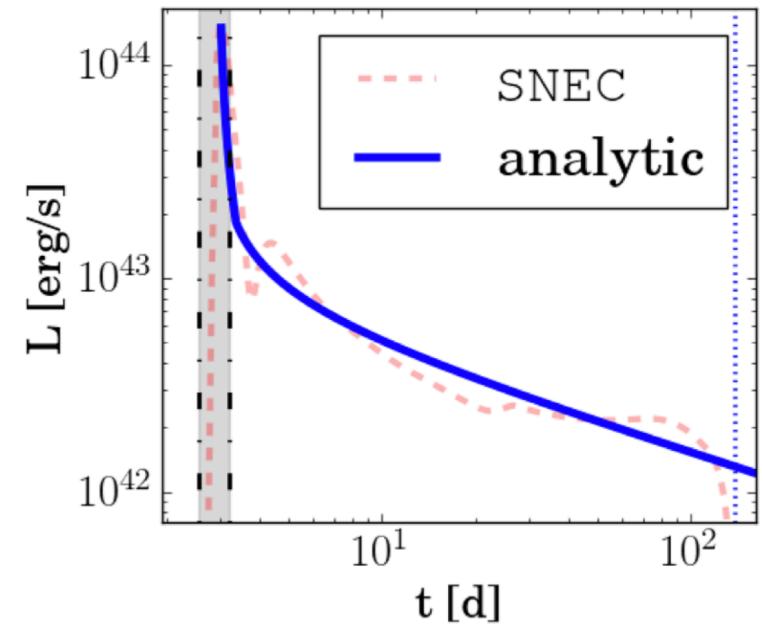
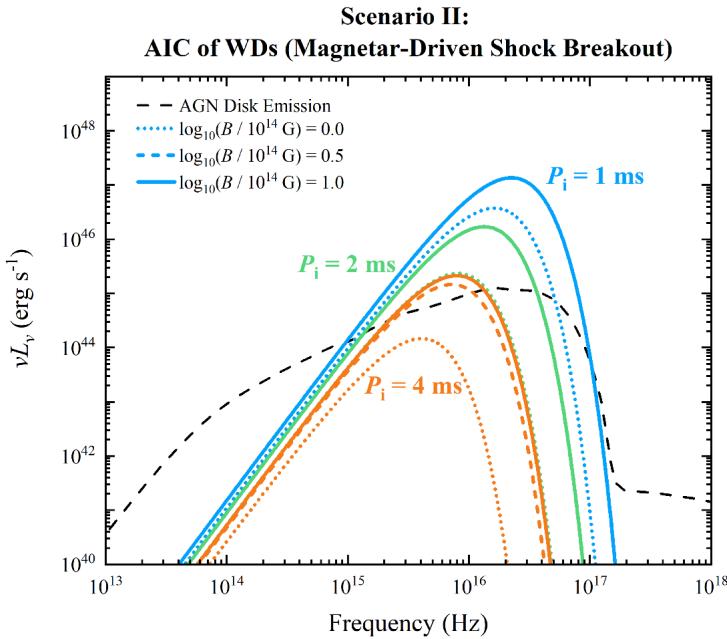
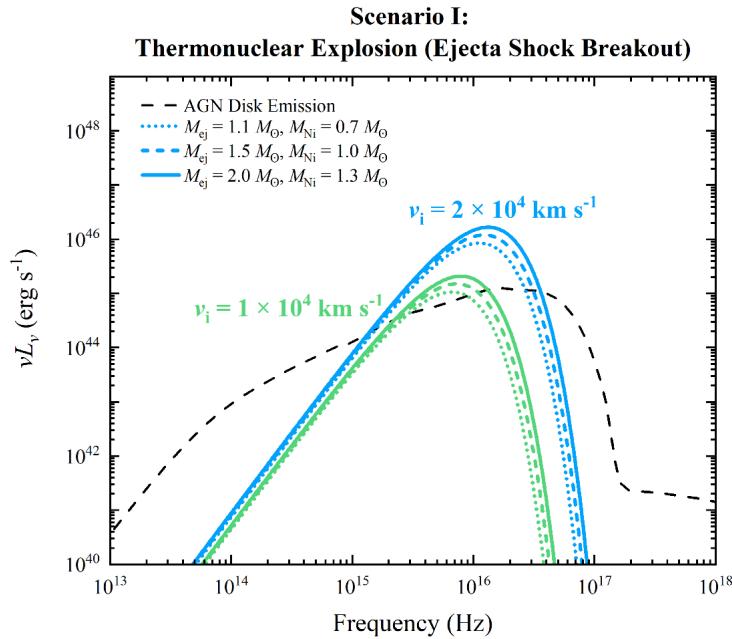


- Accretion-induced Collapse of White Dwarfs: Magnetar-powered Transients



# Transients in AGN Disks

## AGN AICs of WDs



### Ejecta Shock Breakout:

- Temperature  $T_{\text{obs}} \approx 1.5 \times 10^5 \text{ K}$
- Duration  $t_{\text{diff}} \approx 0.7 \text{ hr}$
- Luminosity  $L \approx 1.6 \times 10^{46} \text{ erg s}^{-1}$

### Magnetar-Driven Shock Breakout:

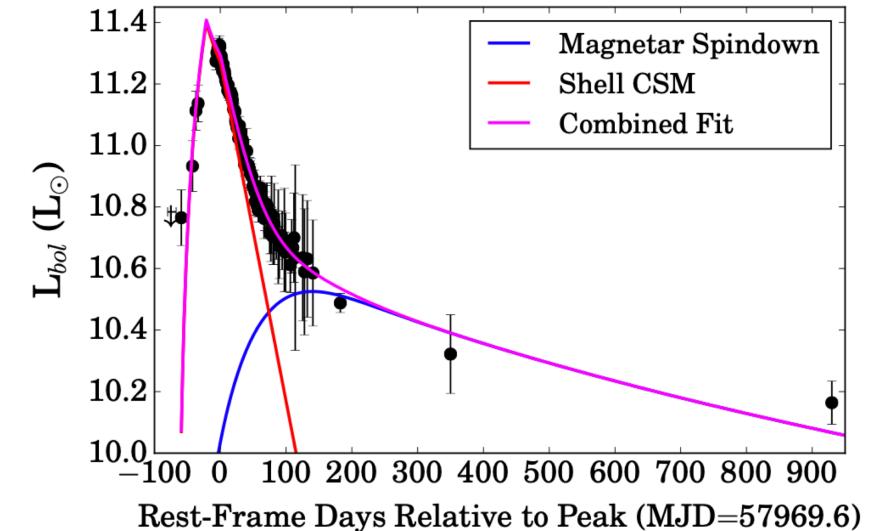
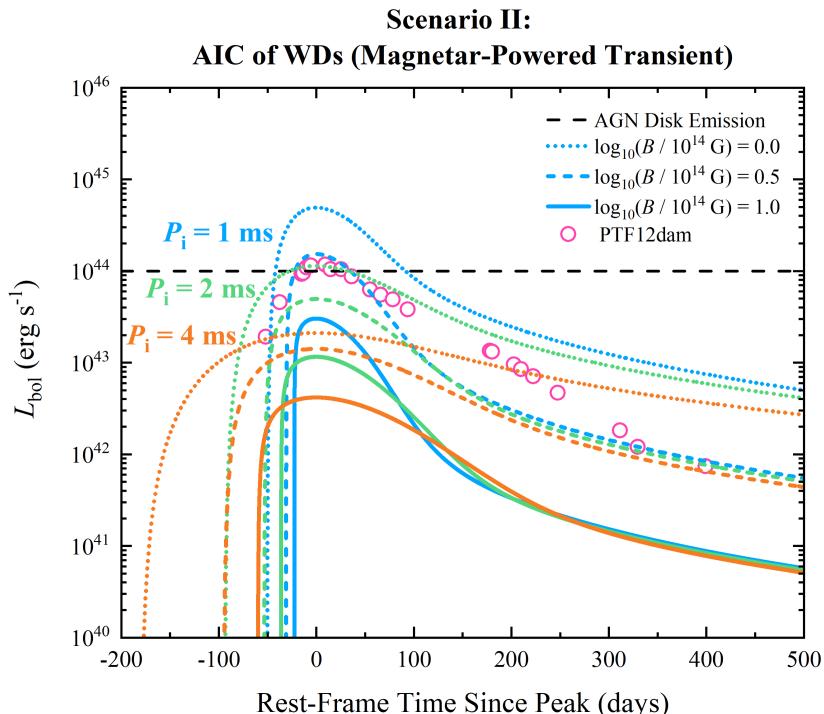
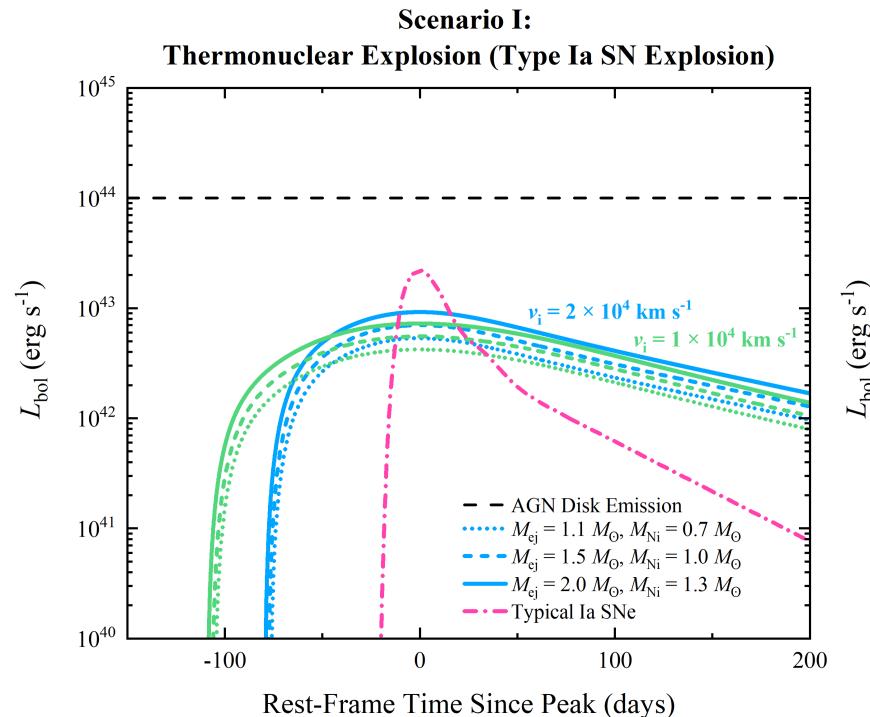
- Temperature  $T_{\text{obs}} \approx 9.9 \times 10^4 \text{ K}$
- Duration  $t_{\text{diff}} \approx 2.1 \text{ hr}$
- Luminosity  $L \approx 3.2 \times 10^{45} \text{ erg s}^{-1}$

Grishin et al. 2021

### Shock Breakout CSM Lightcurve

# Transients in AGN Disks

## AGN AICs of WDs



Holoien et al. (2022)

- Dim slow-evolving type Ia SN for thermonuclear explosion
- Fast-evolving bright transient or SLSN-like transient for AIC of WDs in AGN disks

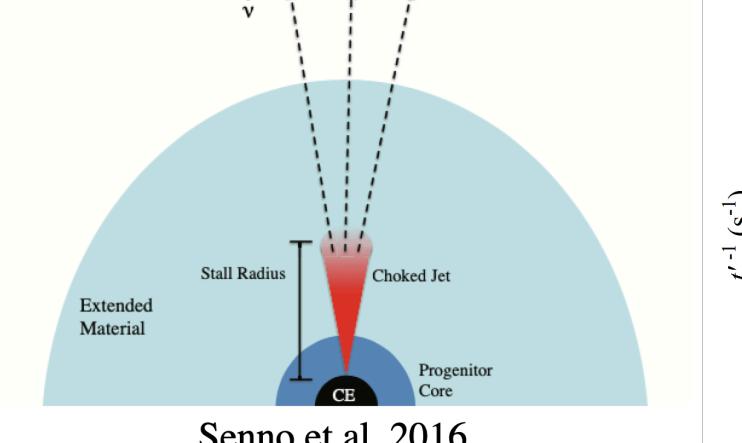
- Candidate

# Transients in AGN Disks

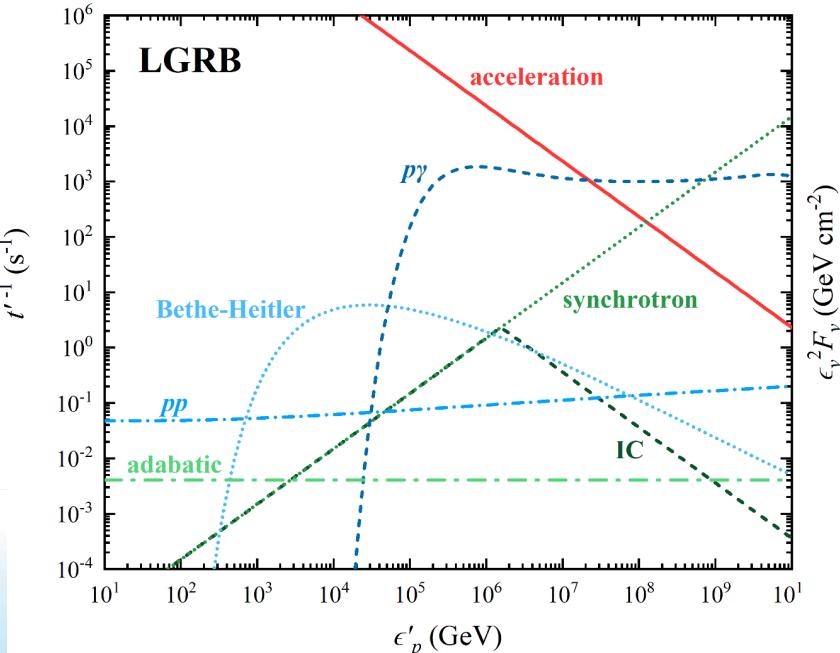
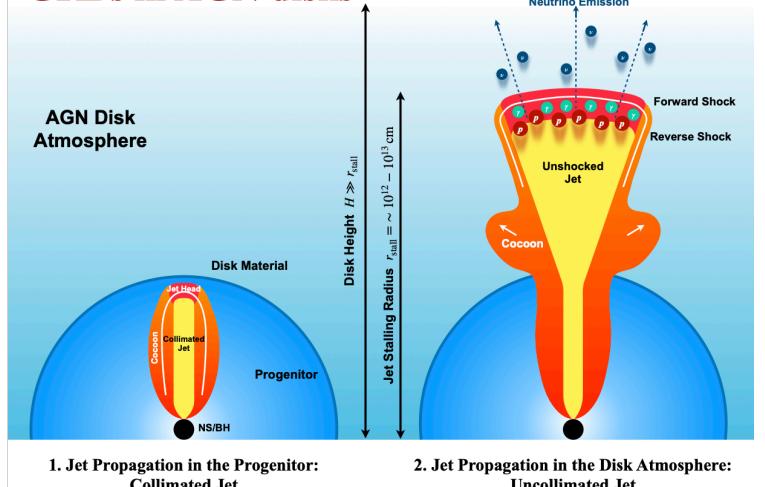
Neutrinos from choked jets

Orphan Neutrinos

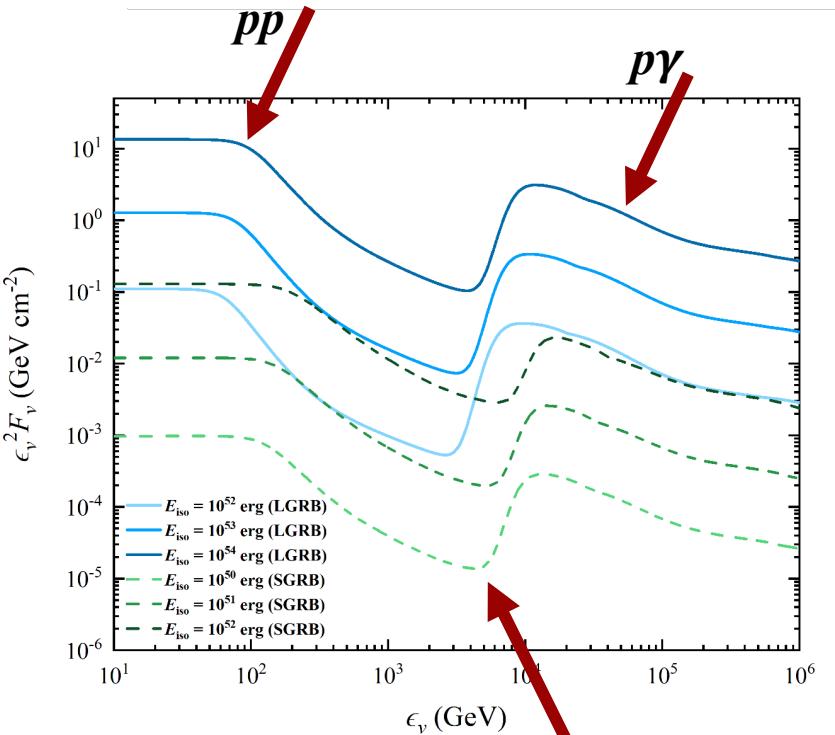
- Low-luminosity GRB



- GRBs in AGN disks



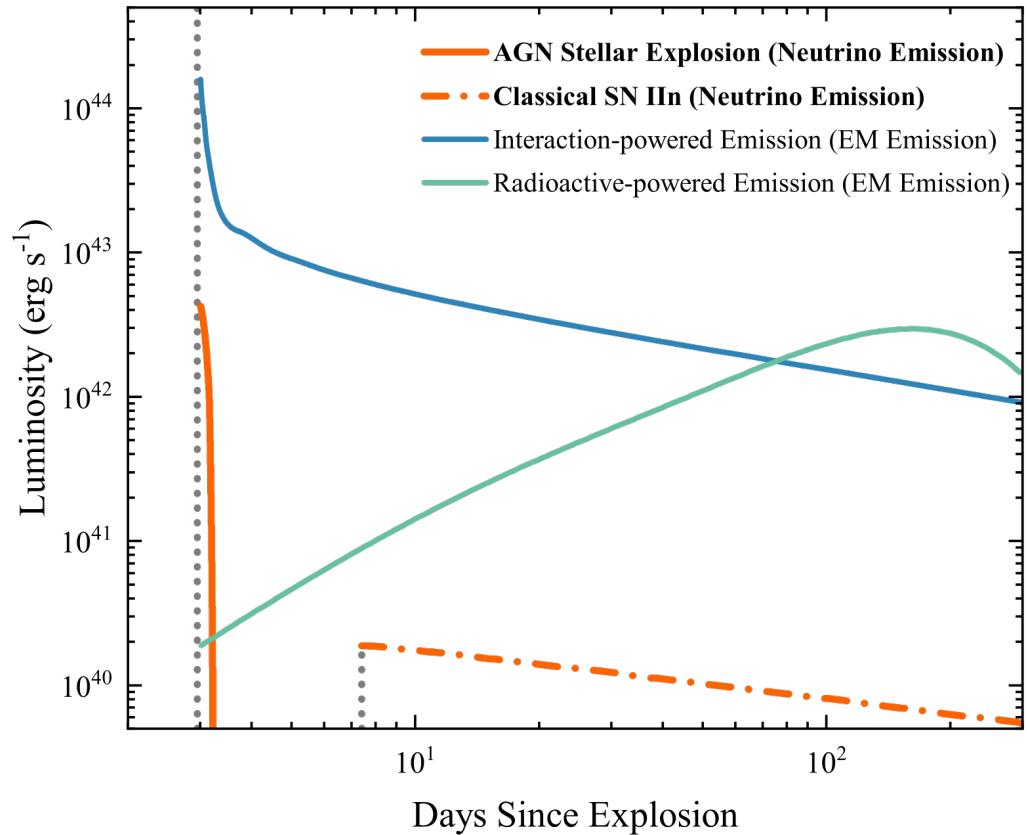
Decelerate timescale



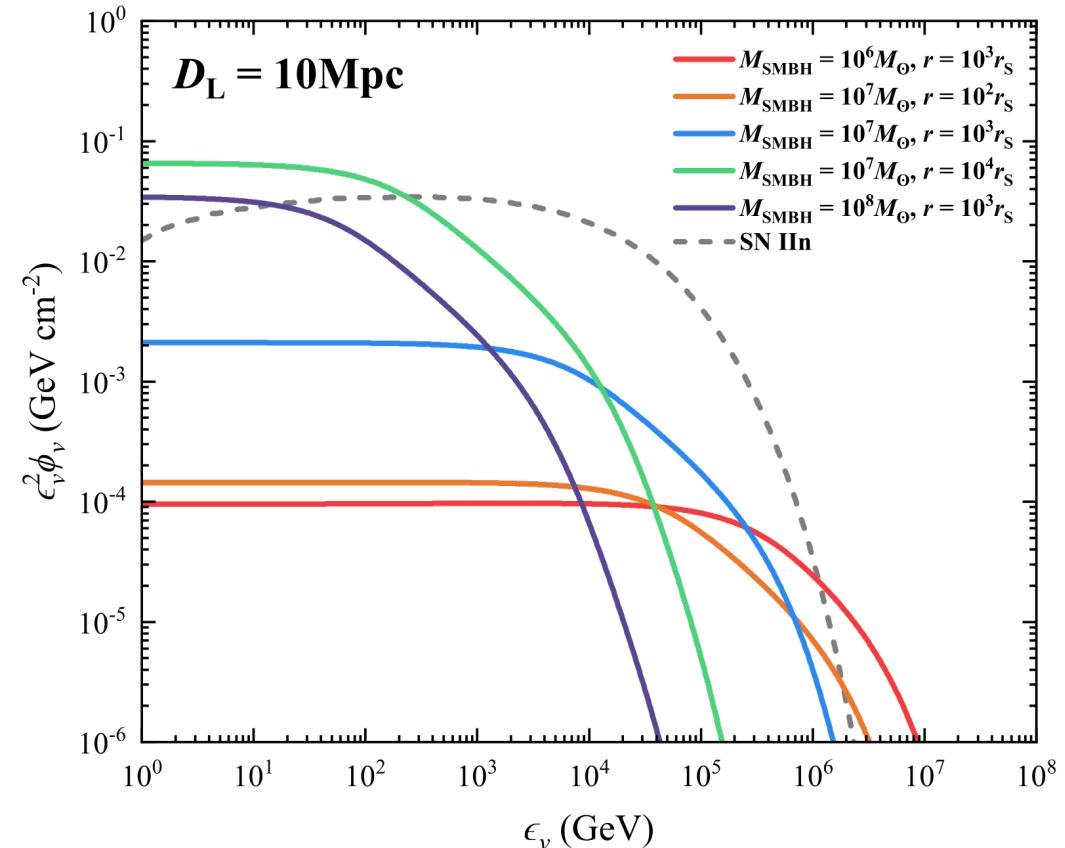
Choked jets in AGN disks can produce high-energy neutrinos detected by IceCube.

# Transients in AGN Disks

Neutrinos from choked jets



Lightcurves

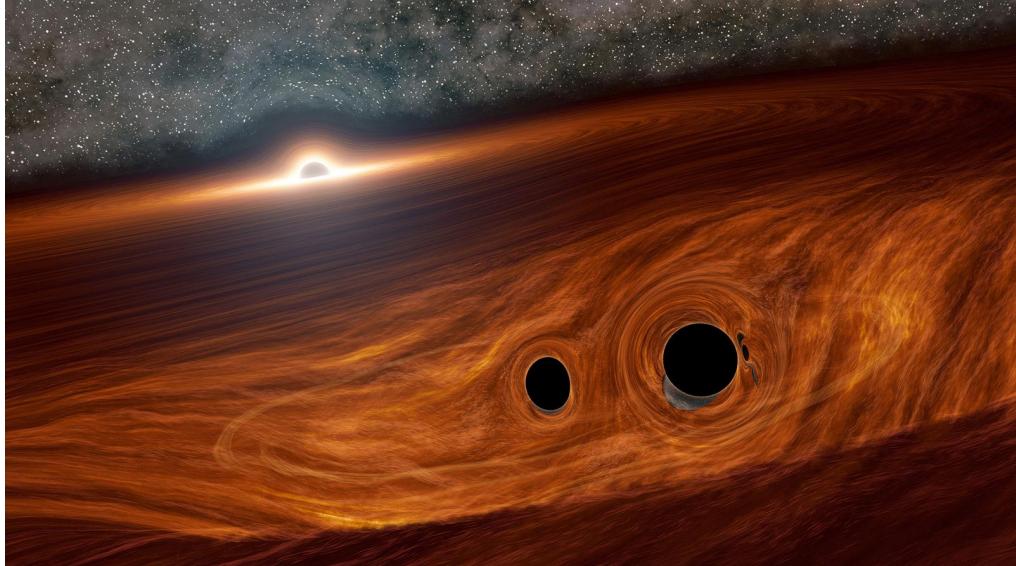


Spectrum

Zhu et al. 2021d, ApJL, 917, L28

AGN transients would be multimessenger sources in GW, EM and neutrino.

# Summary



## Multimessenger Source: AGN Transients

- AGN neutron star mergers
- AGN AICs of WDs
- Neutrinos from choked jets
- Neutrinos from shock breakouts



谢谢聆听



报告人

朱锦平

2022年6月16日

