

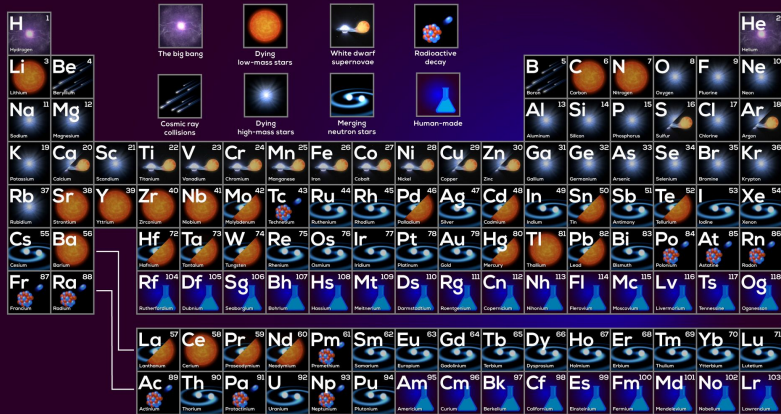
# Kilonovae with Untriggered Roman searches

Jielai Zhang, Jeff Cooke  
Swinburne University of Technology  
Exploring the Transient Universe with the Nancy Grace Roman Space Telescope  
Feb 9, 2022

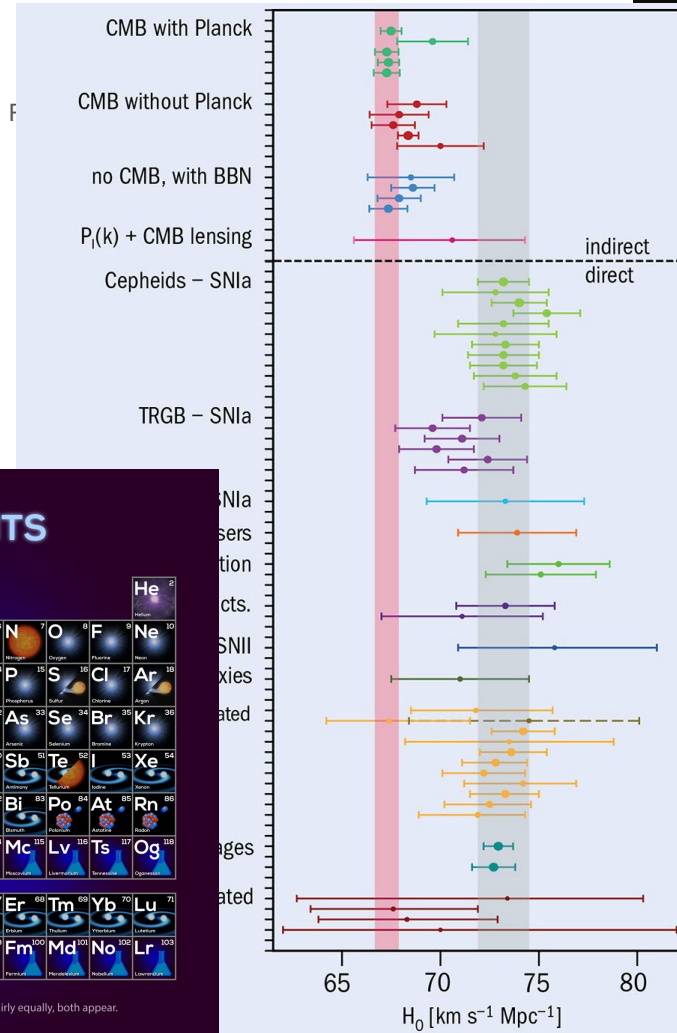
# Why Kilonova

Roman Twitter Feed

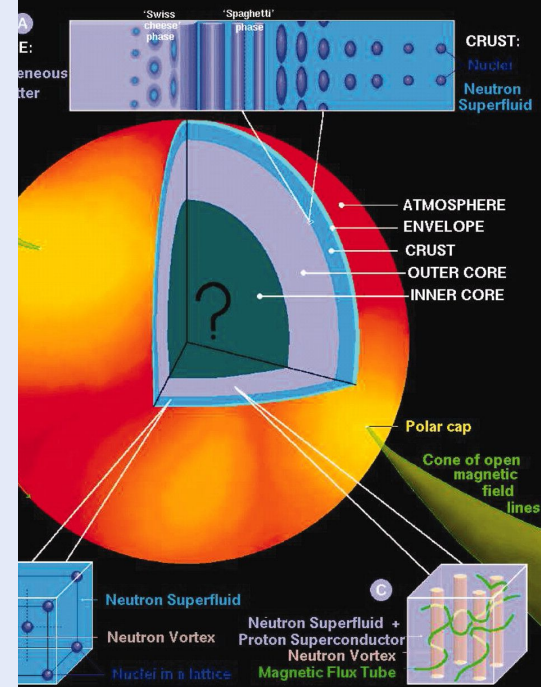
## ORIGINS OF THE ELEMENTS



This periodic table depicts the primary source on Earth for each element. In cases where two sources contribute fairly equally, both appear.



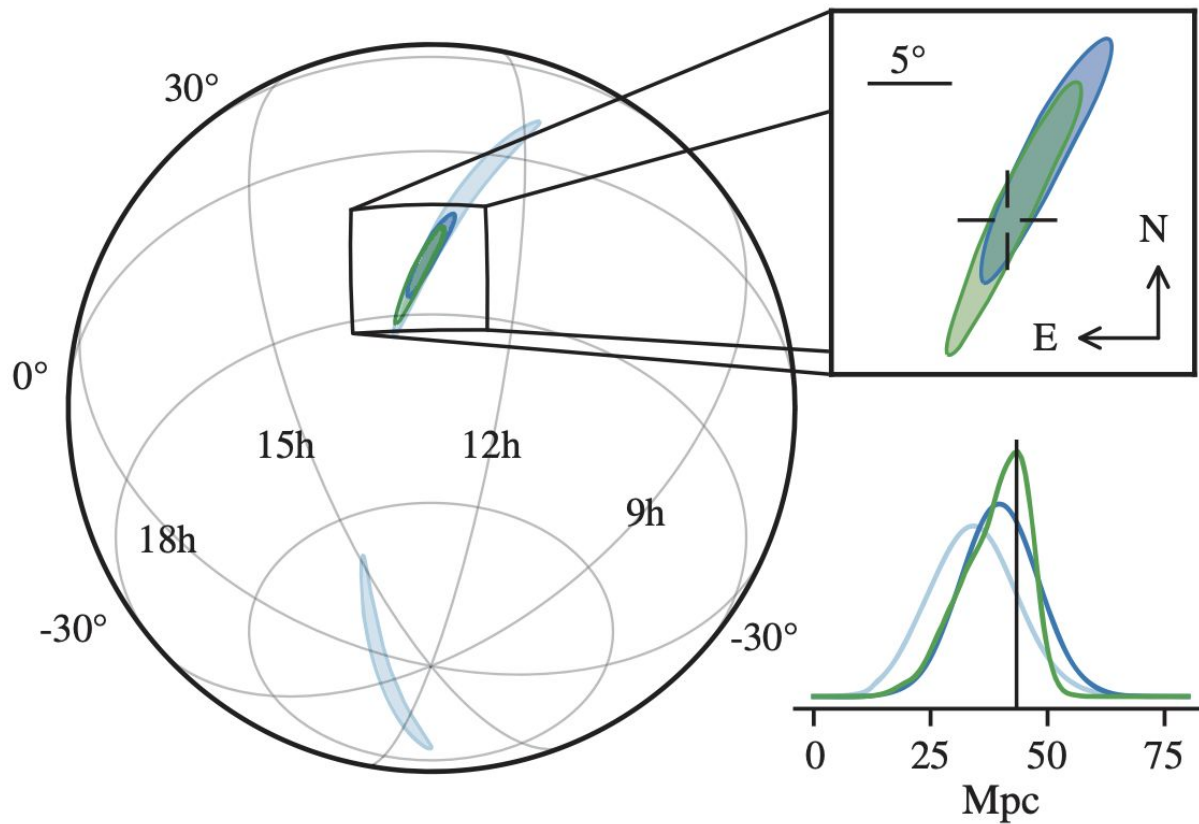
## A NEUTRON STAR: SURFACE AND INTERIOR



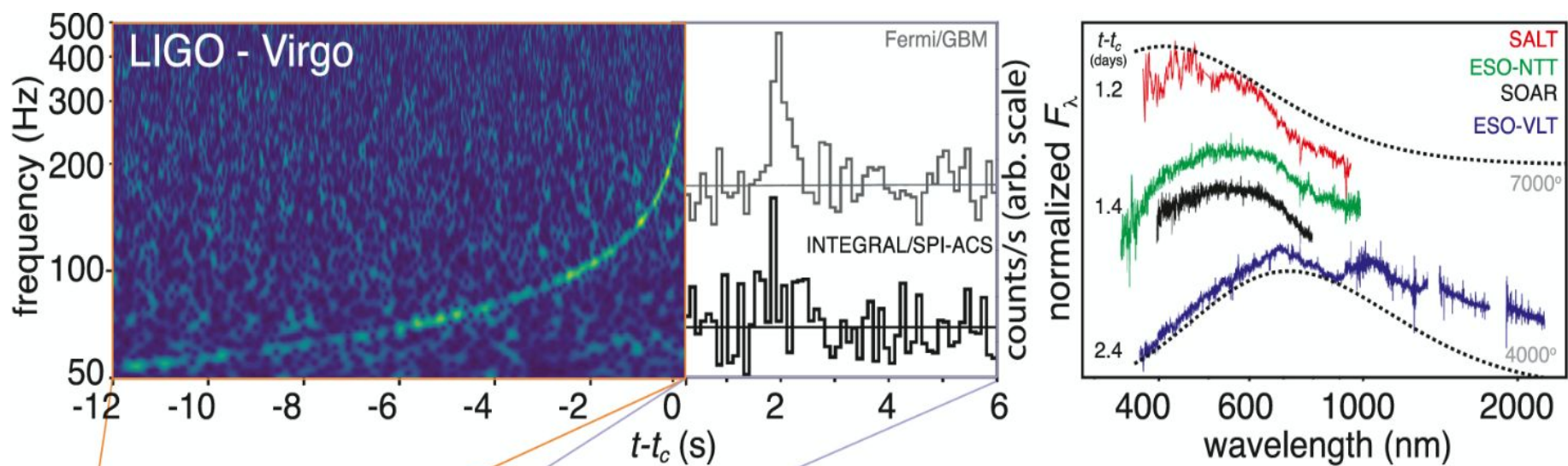
J. M. LATTIMER AND M. PRAKASH,  
*SCIENCE* • 2004 • V304

Eleonora Di Valentino *et al* 2021 *Class. Quantum Grav.* 38 153001

“Typical” approach to finding KN



Localisation:  
28 square degrees  
(green contours).



B. P. Abbott *et al* 2017 *ApJL* 848 L12

B. P. Abbott *et al* 2017 *ApJL* 848 L12

**X-ray**  
Swift, MAXI/GSC, NuSTAR, Chandra, INTEGRAL

**UV**  
Swift, HST

**Optical**

Swope, DECam, DLT40, REM-ROS2, HST, Las Cumbres, SkyMapper, VISTA, MASTER, Magellan, Subaru, Pan-STARRS1, HCT, TZAC, LSGT, T17, Gemini-South, NTT, GROND, SOAR, ESO-VLT, KMTNet, ESO-VST, VIRT, SALT, CHILESCOPE, TOROS, BOOTES-5, Zadko, iTelescope.Net, AAT, Pi of the Sky, AST3-2, ATLAS, Danish Tel, DFN, T80S, EABA

**IR**

REM-ROS2, VISTA, Gemini-South, 2MASS, Spitzer, NTT, GROND, SOAR, NOT, ESO-VLT, Kanata Telescope, HST

**Radio**

ATCA, VLA, ASKAP, VLBA, GMRT, MWA, LOFAR, LWA, ALMA, OVRO, EVN, e-MERLIN, MeerKAT, Parkes, SRT, Effelsberg

-100 -50 0 50

$t-t_c$  (s)

$10^{-2}$

$10^{-1}$

$t-t_c$  (days)

$10^0$

$10^1$

1M2H Swope

10.86h

DLT40

11.08h

VISTA

11.24h

Chandra

9d

MASTER

11.31h

DECam

11.40h

Las Cumbres

11.57h

J VLA

16.4d

*i*

*h*

*YJK<sub>s</sub>*

*X-ray*

*W*

*i<sub>Z</sub>*

*w*

*Radio*

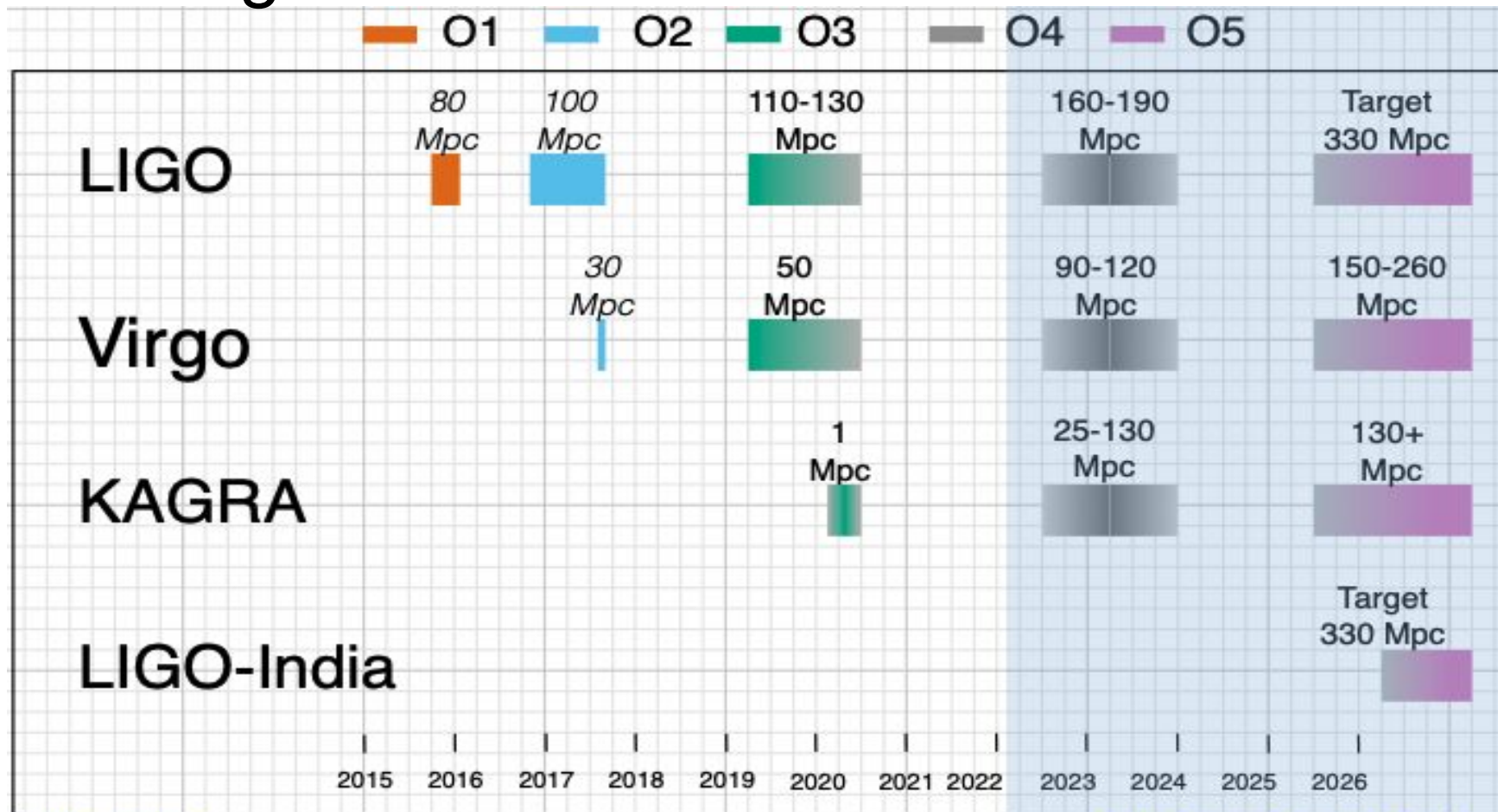
# Untriggered Optical/IR Search: Why and How

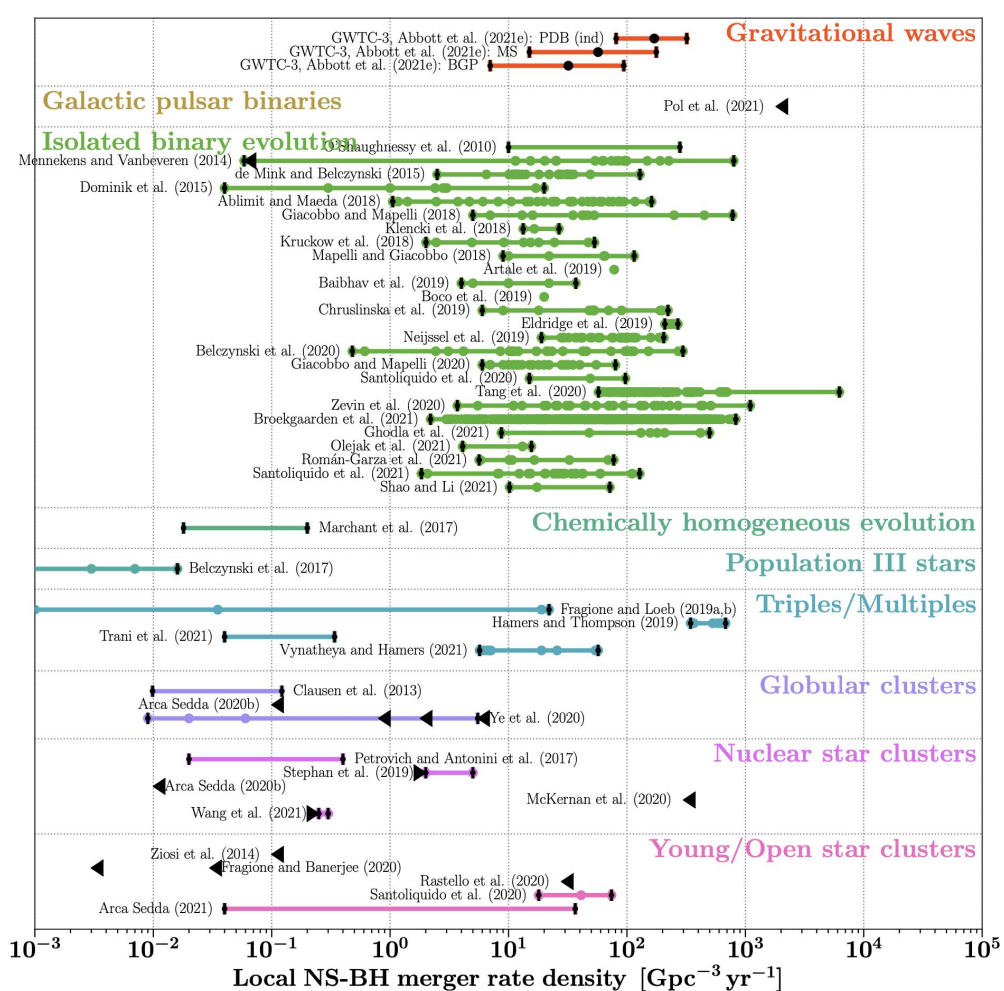
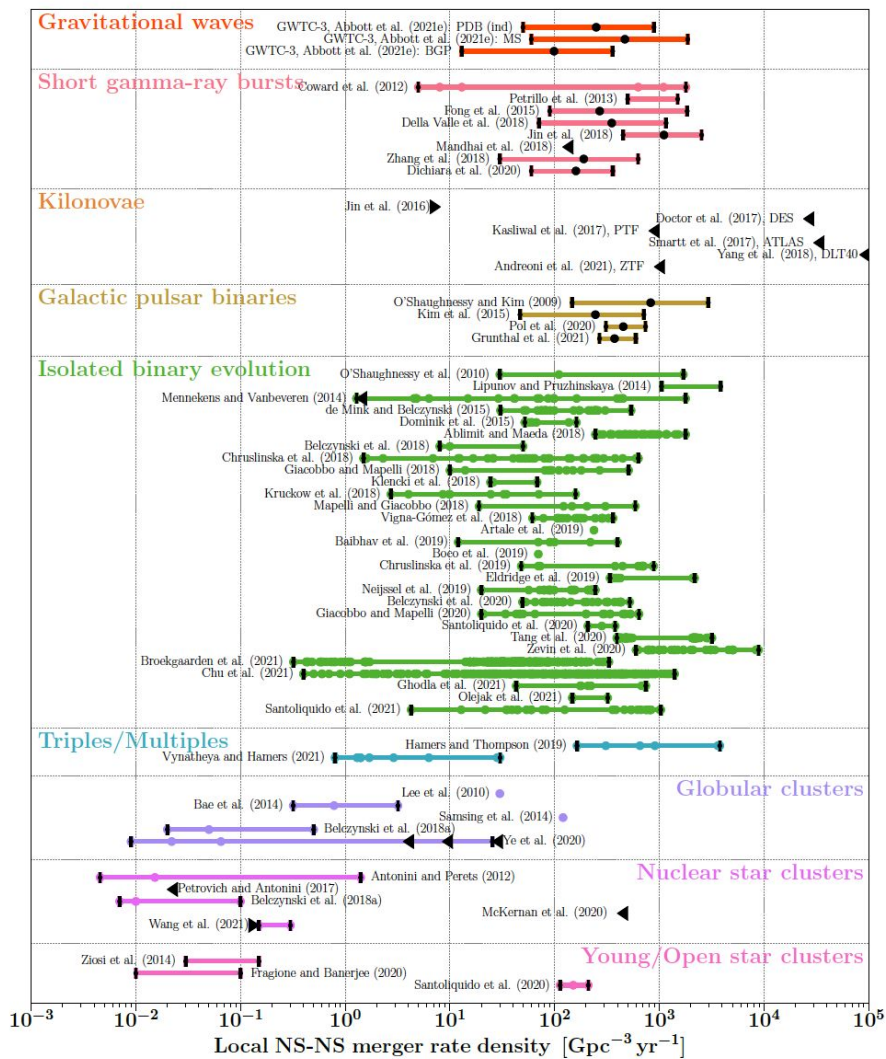
Want to increase rate of KN detection and confirmation.

An alternative is untriggered search in optical and IR.



# BNS ranges

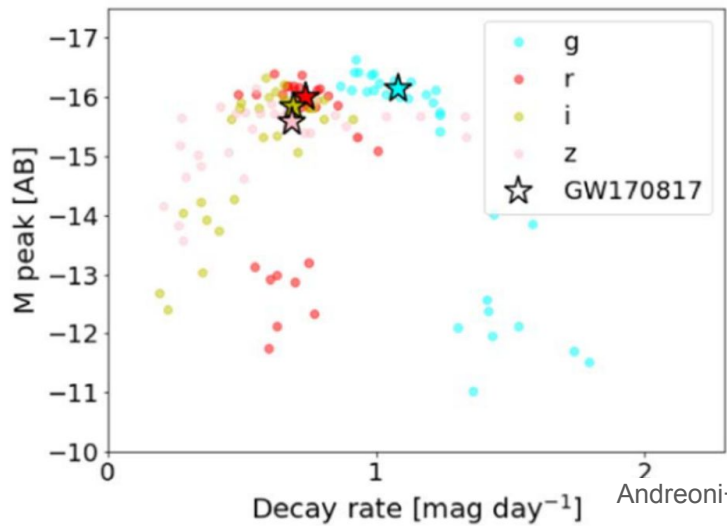
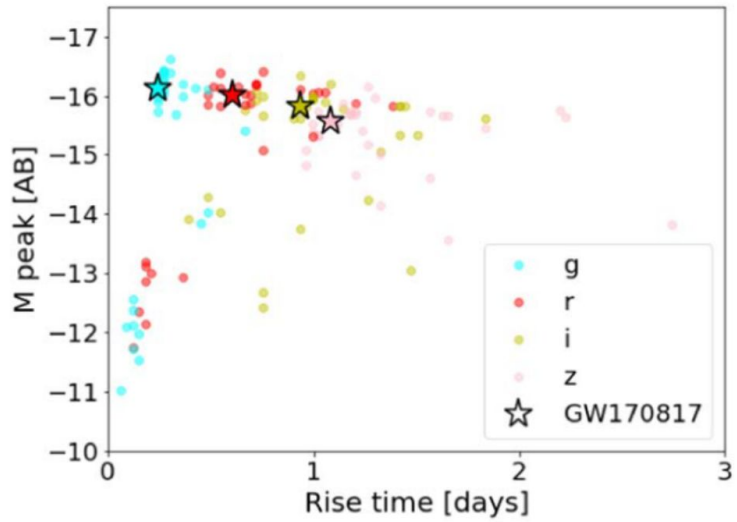




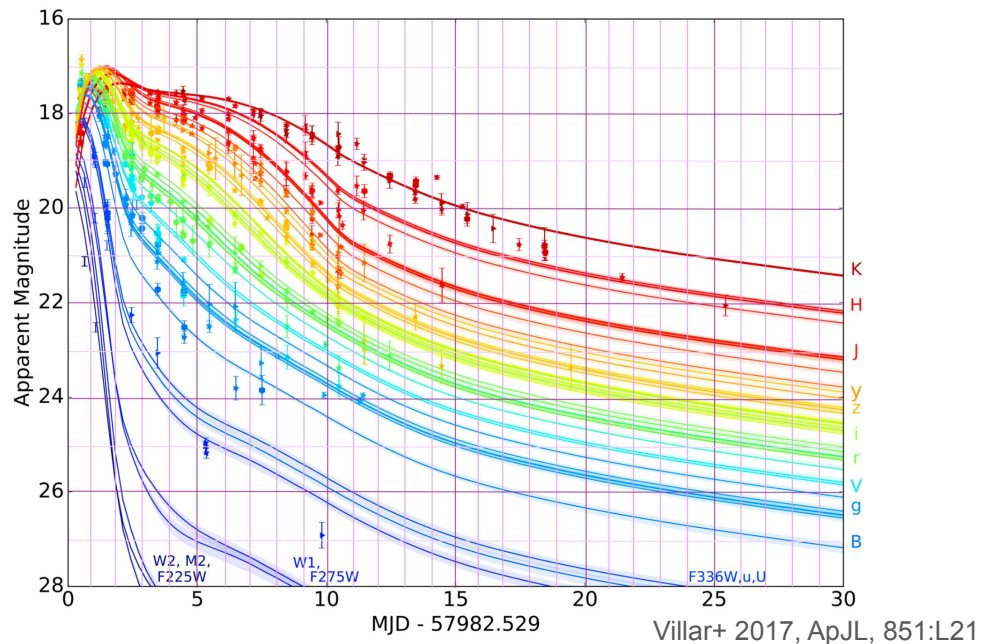
Optical/IR

@24 mag,  $z=0.26$ ,  $D=1.1\text{Gpc}$

Different selection effects



Andreoni+ 2019, PASP, 131:068004



Optimal strategy for search in  
 Optical/IR: 2 filters  
 Day-cadence (optical)  
 2 day cadence (IR)

# Case Study: DECam

## Up to 1KN/49 days

FOV: 3 sq deg, Assume  $M=-16.7$ ,  $R=800/\text{Gpc}^3/\text{yr}$   
420s g-band, 510s i-band (depth 24 mag, bright time)  
23 fields / 8 hr night

Will happen Feb 11-21, 2022!

Together with

Igor Andreoni, Jeff Cooke, Armin Rest, Anais Moller, Dougal Dobie,  
Simon Goode, Frank Valdes, Katie Auchettl, Bruce Gendre, James  
Freeburn, Amy Lien, Lee Spitler

# Case Study: Roman

## Up to 1KN/16 days

FOV: 0.28 sq deg, Assume  $M=-16.7$ ,  $R=800/\text{Gpc}^3/\text{yr}$   
1hr F184 filter, 1hr Y106 filter (depth 27.5 mag)  
24 fields / 2 days

# **Comparison: O4 LIGO/VIRGO**

**Up to 1 NS merger/16 days**

(Finding KN depends on localisation and search success)

Assuming  $R=800/\text{Gpc}^3/\text{yr}$ , best case sensitivity