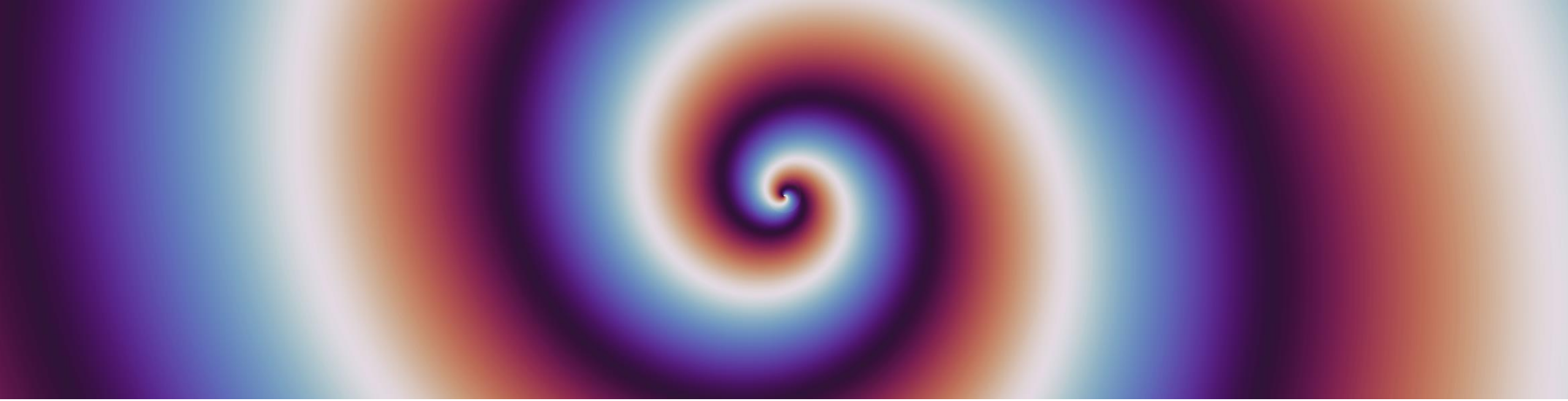


Transients

Intro slides to the discussion

Marc Klinger, Ruslan Konno, Stefan Ohm, Andrew Taylor

HELMHOLTZ WEIZMANN
RESEARCH SCHOOL
MULTIMESSENGER ASTRONOMY

HELMHOLTZ

DESY.

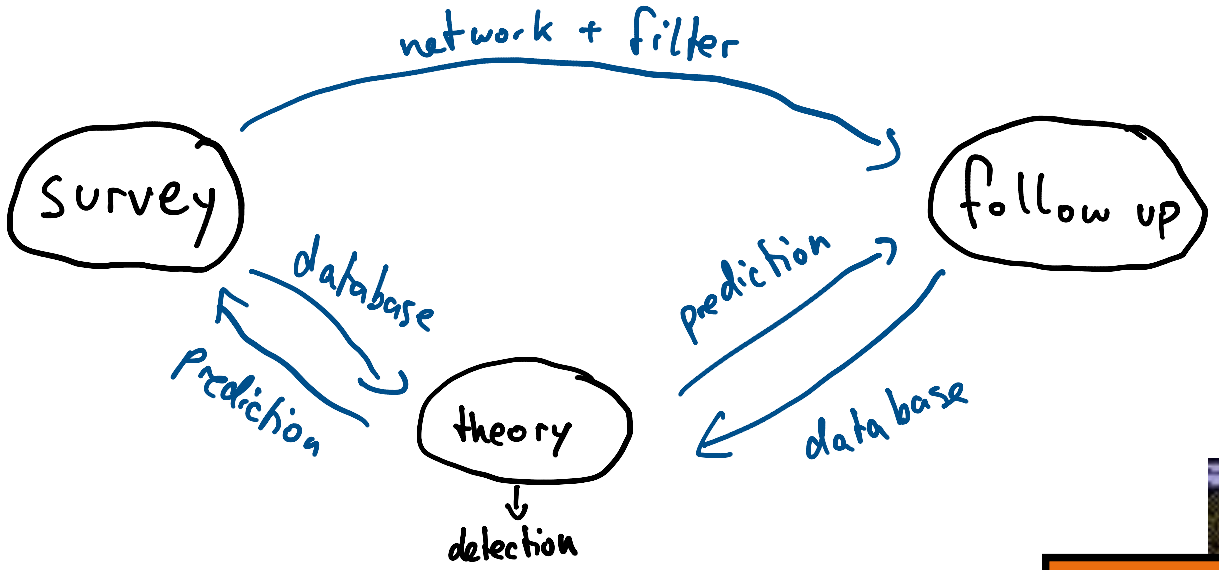
Transients

definition via observational signature:
non-periodically, temporally-limited excess of messenger

→ classification into categories depending on messenger, energy spectrum and temporal profile, e.g. :

- SN
- GRB
- TDE
- AGN flares
- FBOT
- FRBs
- Novae
- Kilonovae
- …

Transient Timescales

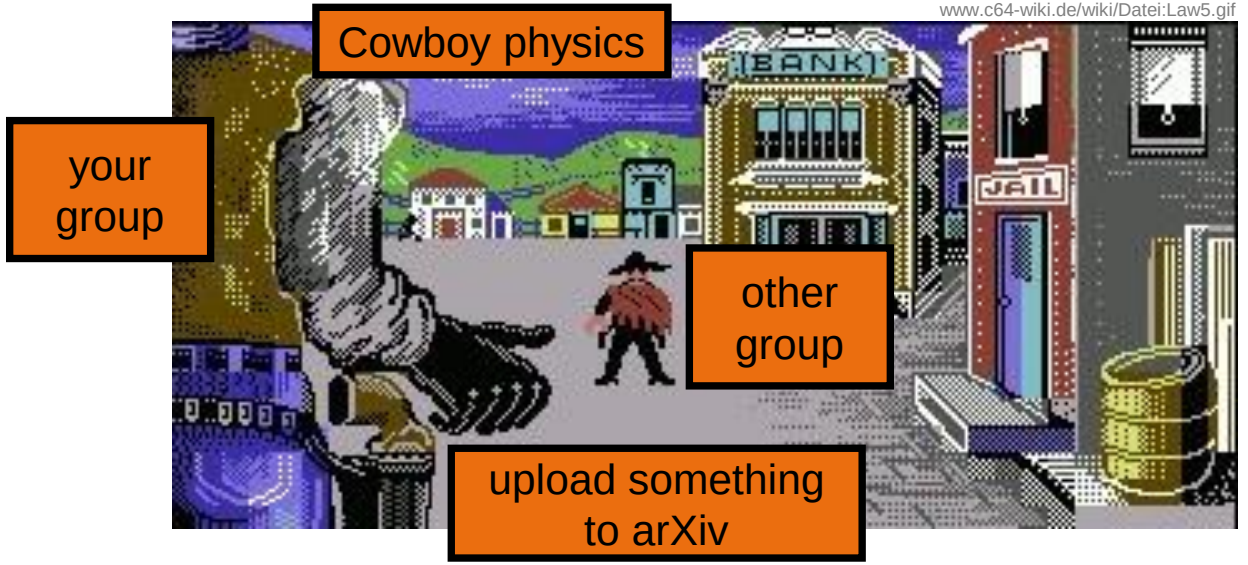


- very fast transients require very fast follow up

  → increasing time scales

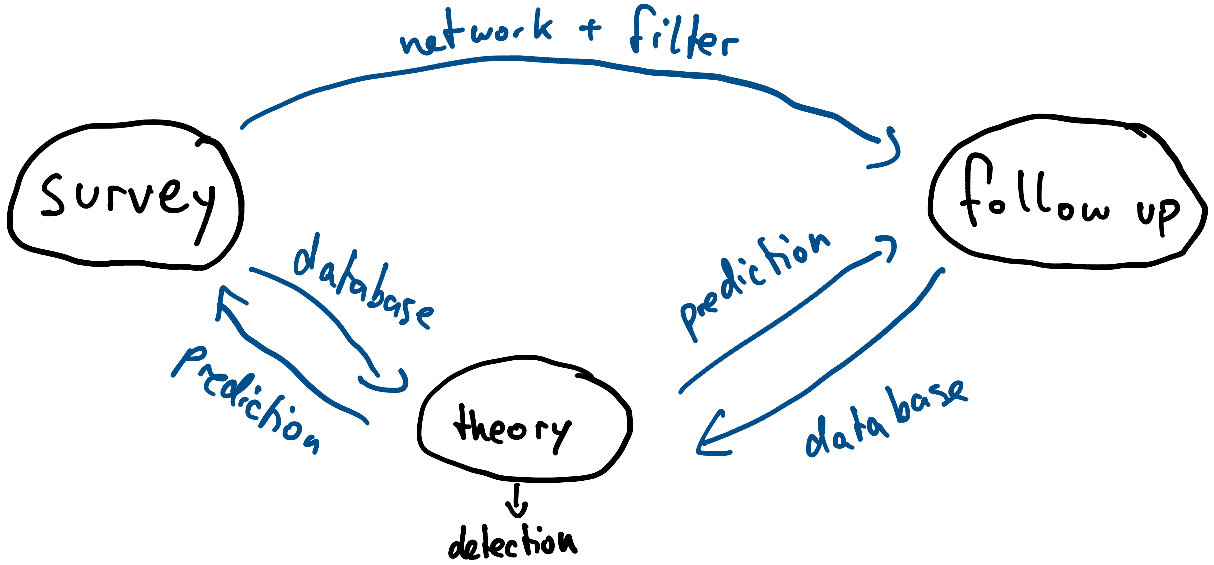
- do we want to increase the other time scales in a similar manner?

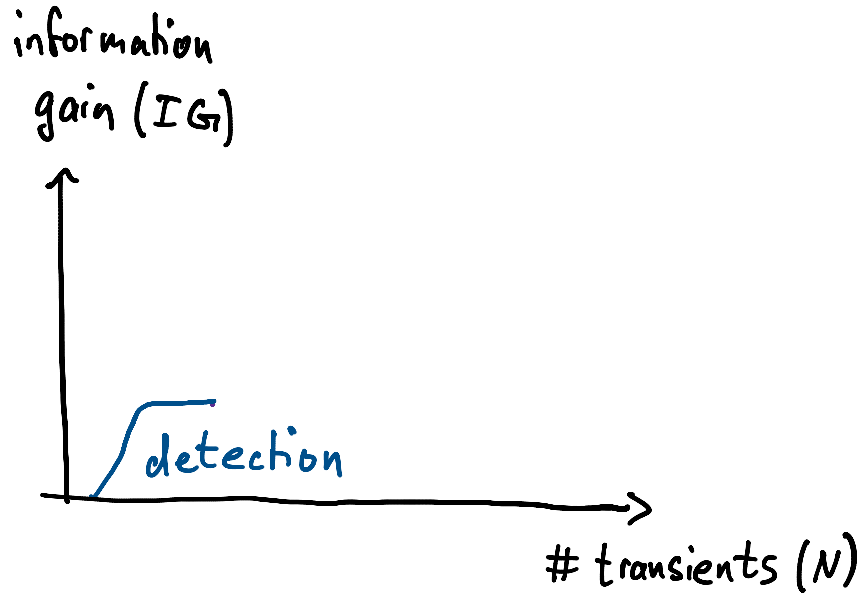
  → transient duration vs. transient rate



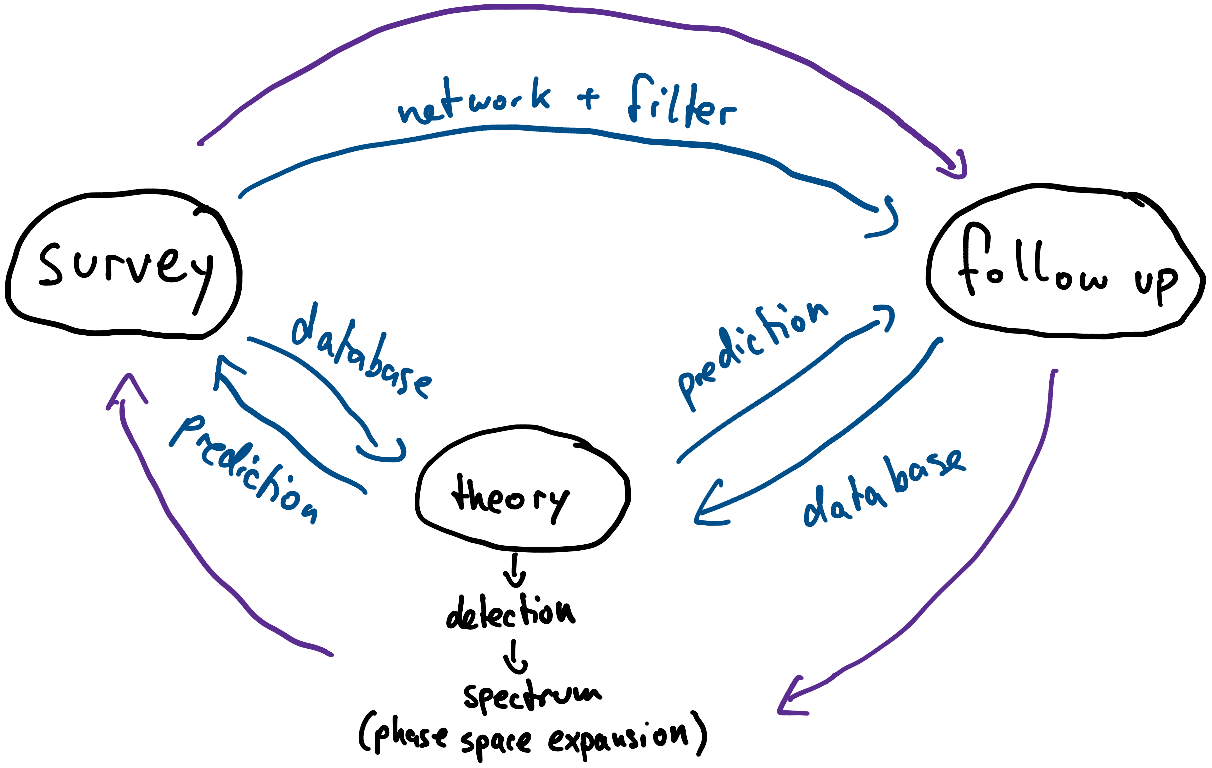
www.c64-wiki.de/wiki/Datei:Law5.gif

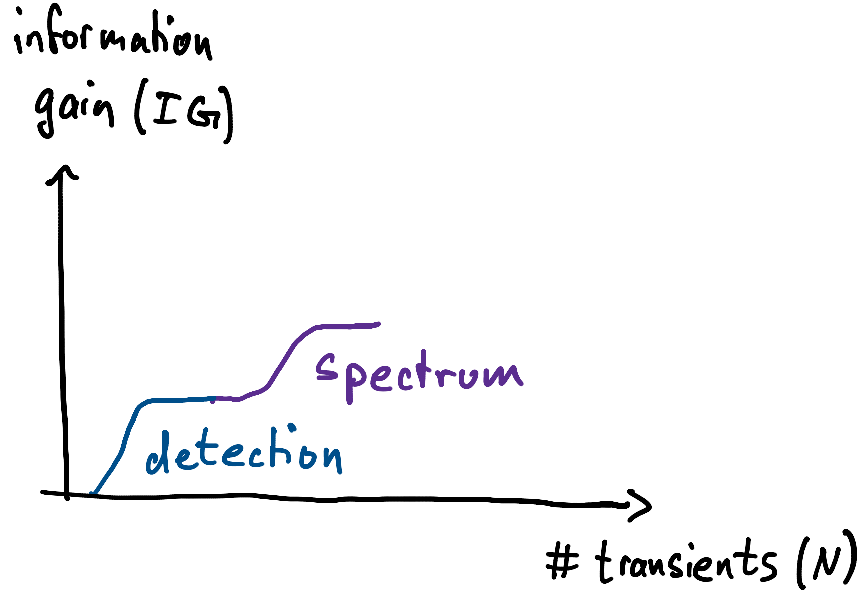
The Transient Spiral



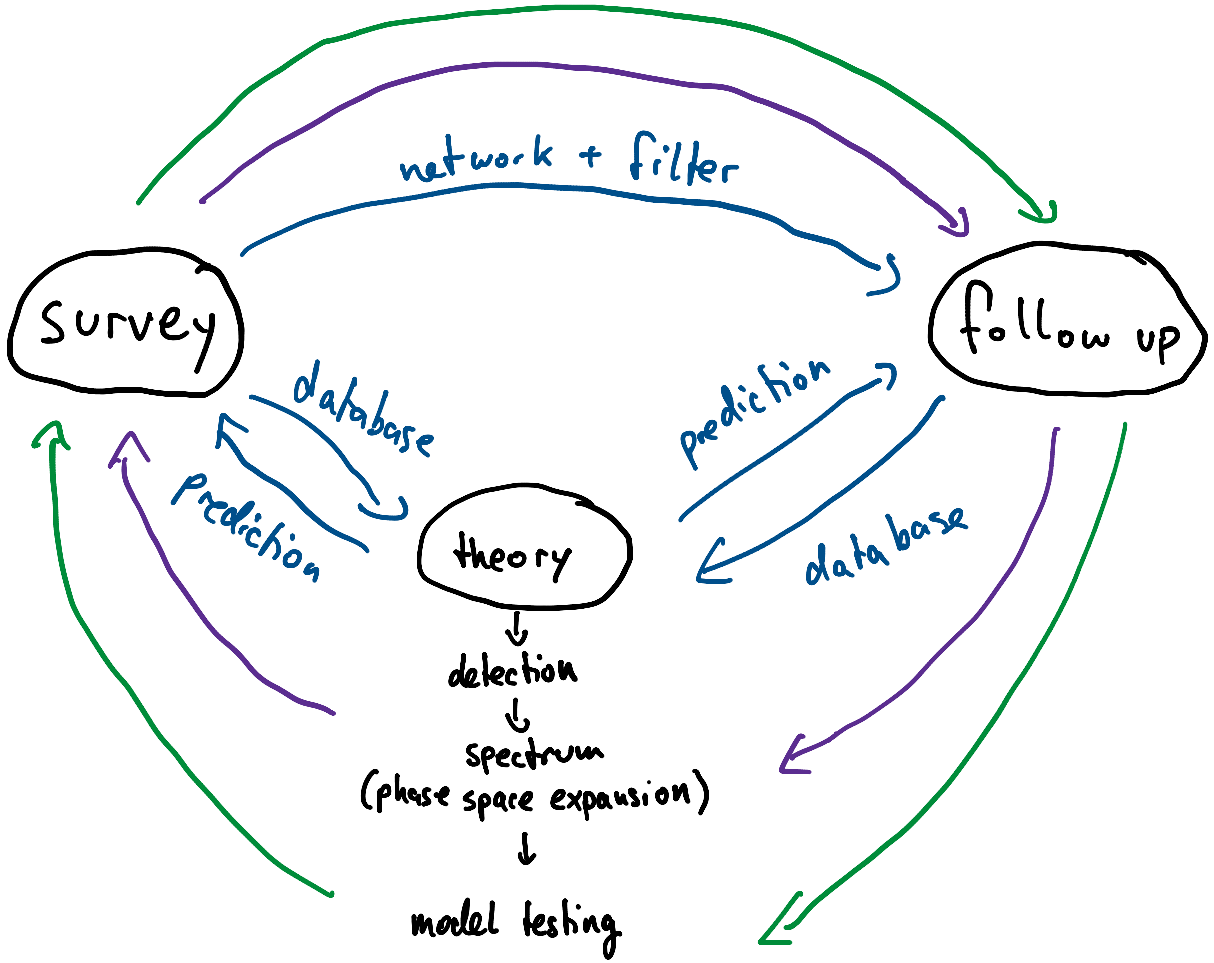


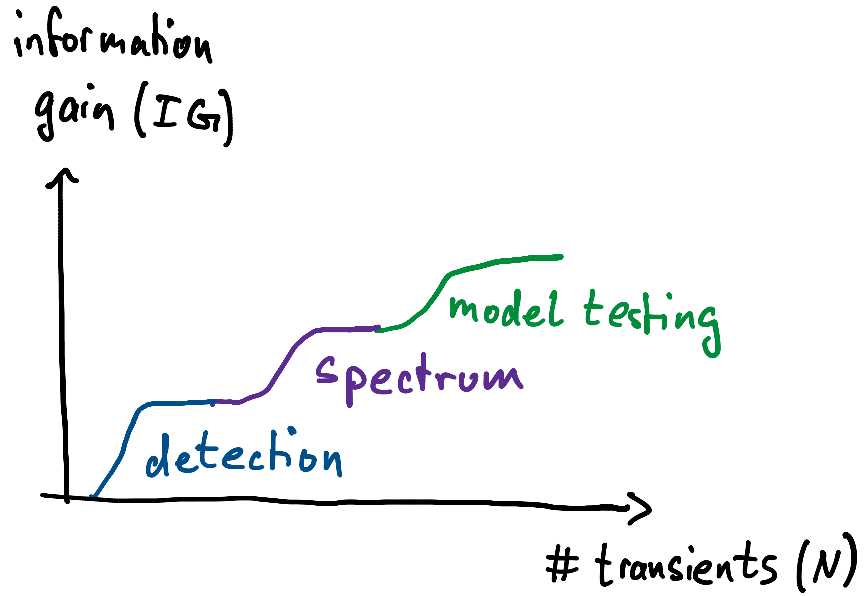
The Transient Spiral



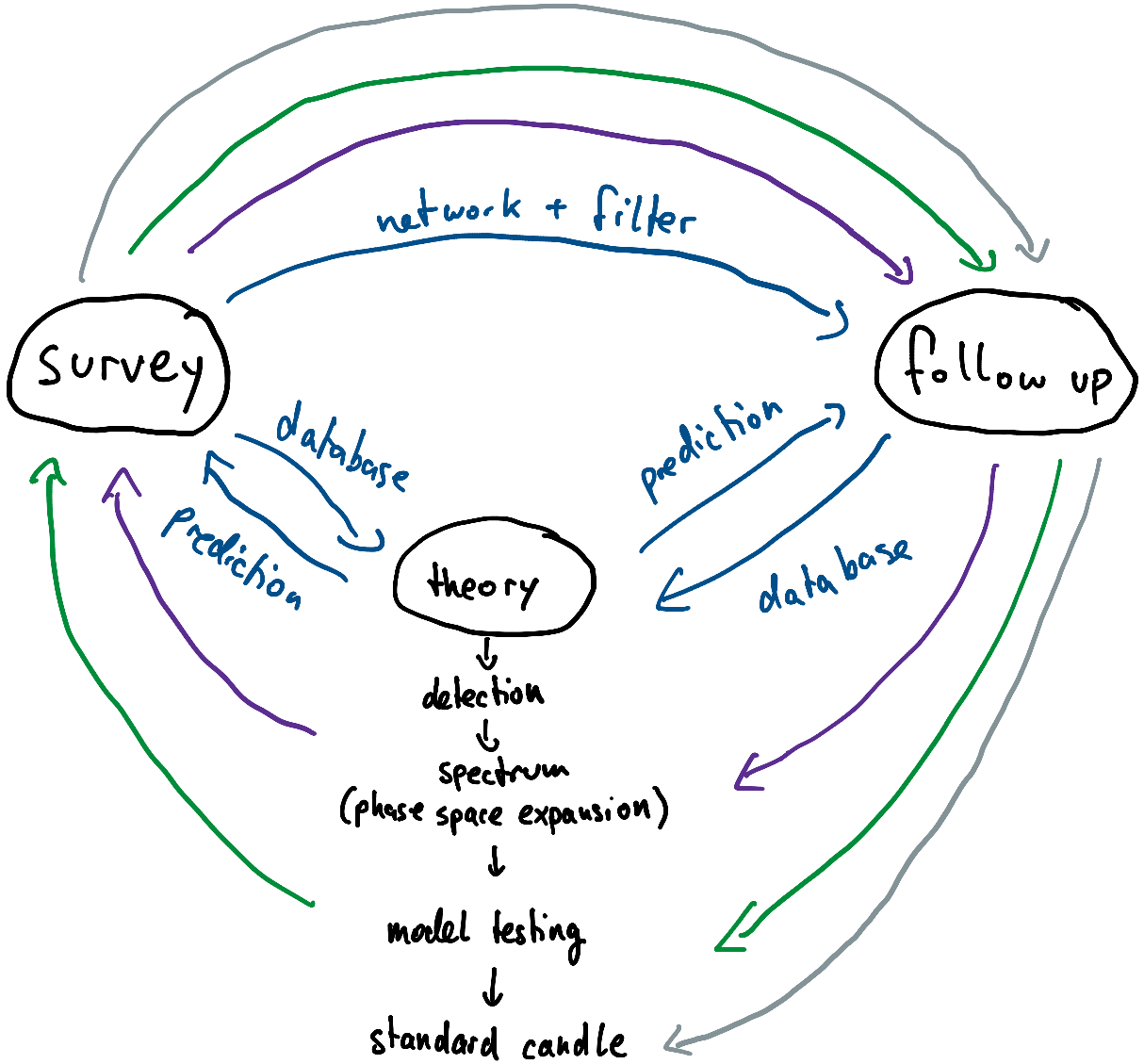


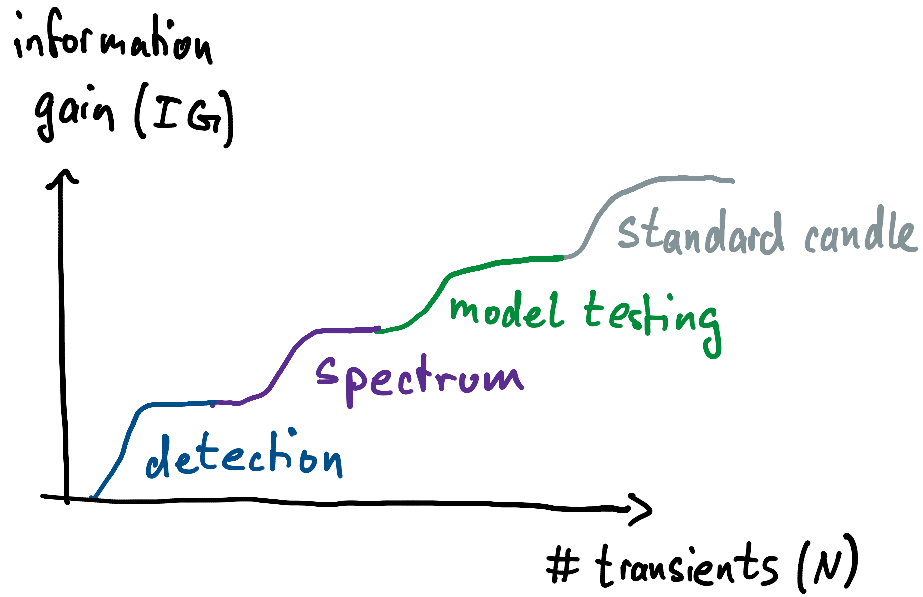
The Transient Spiral



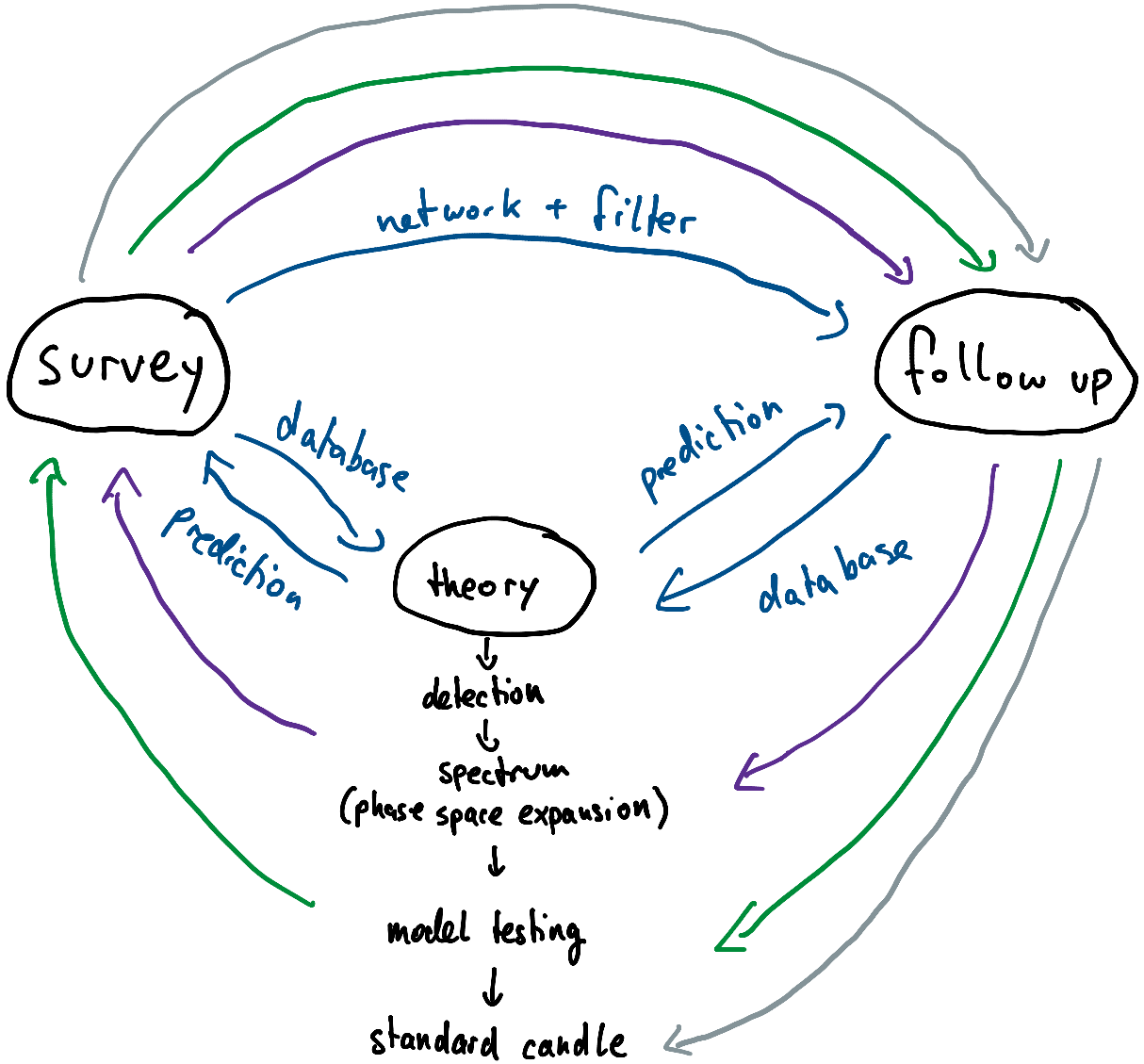


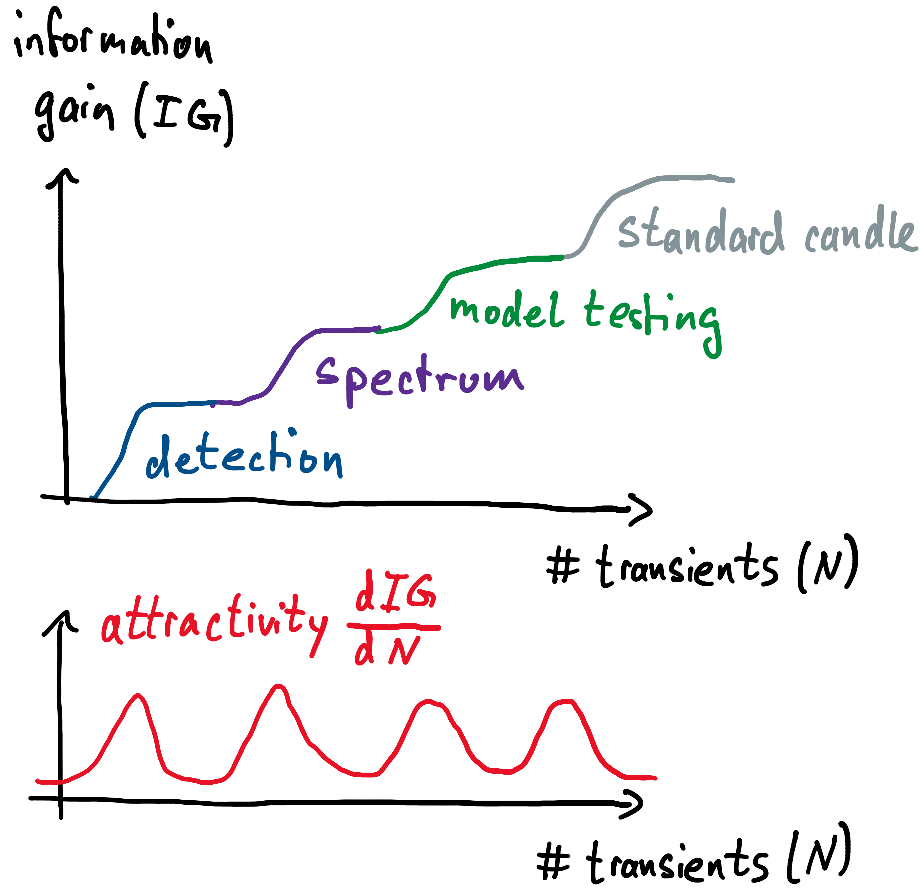
The Transient Spiral





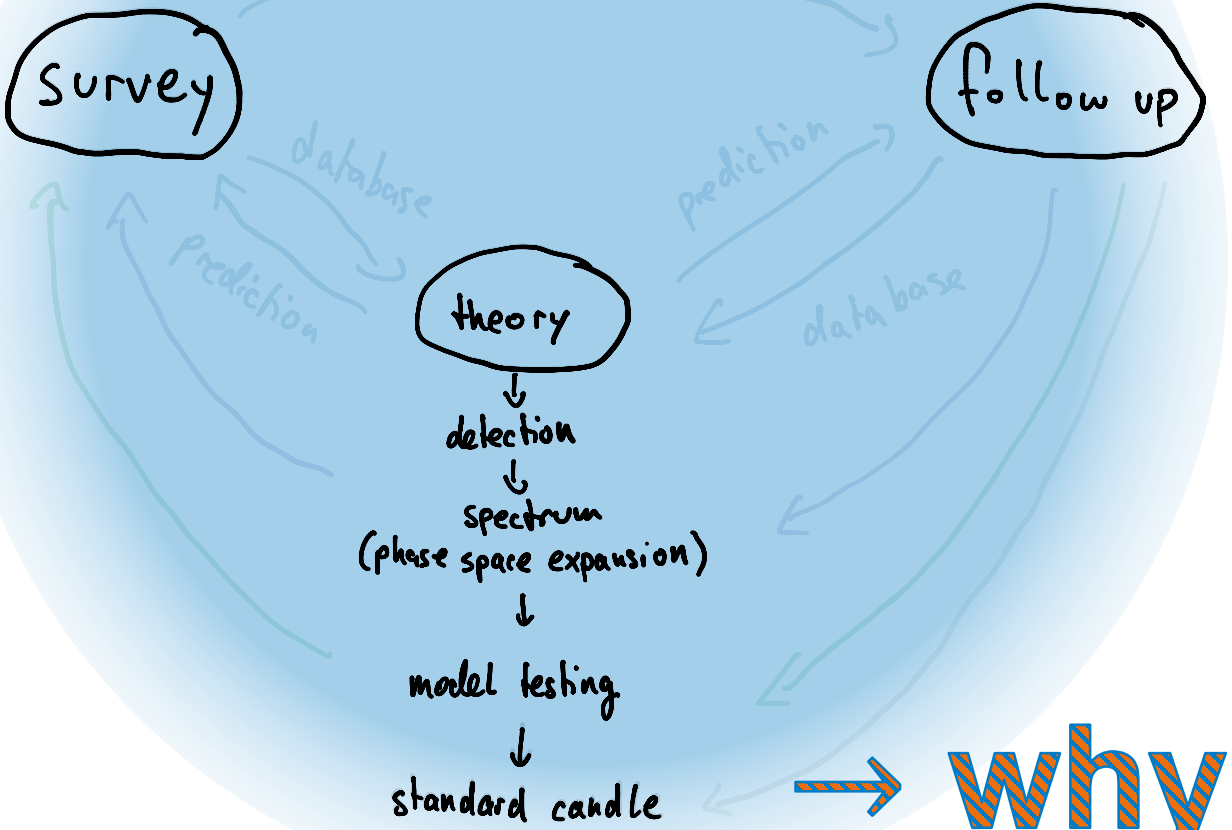
The Transient Spiral

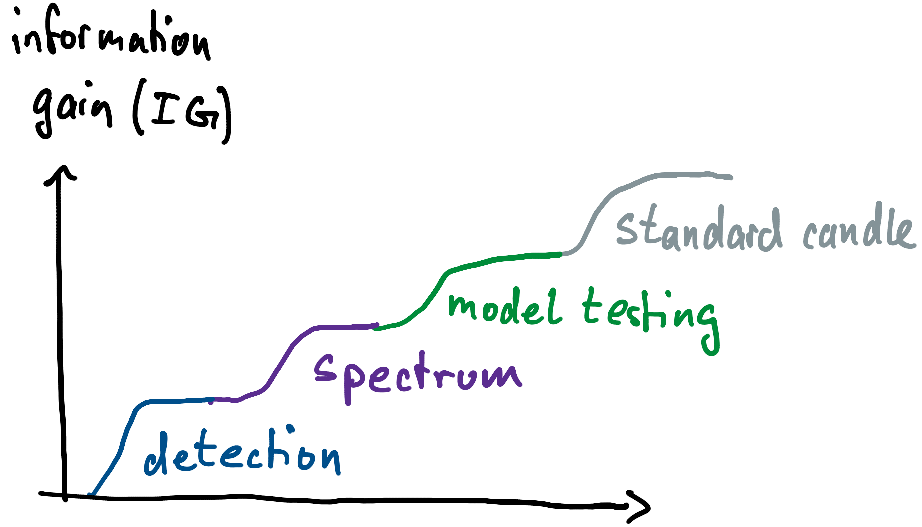


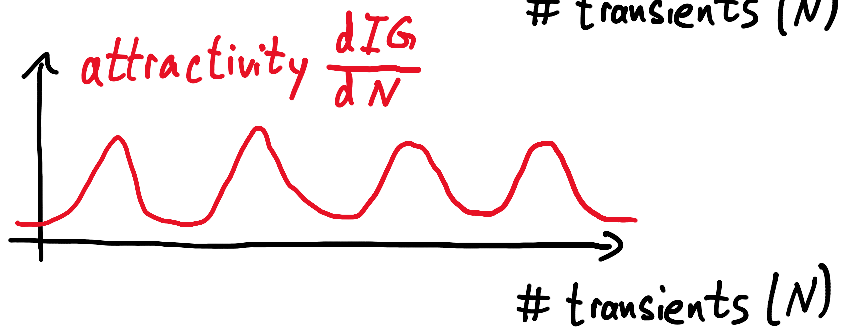


The Transient Spiral

COMMUNICATION







→ why we are here

What do we actually want to learn?

- we can always add information/messengers/people

  → what is the bigger goal?

➢ find the origin of CRs ?

➢ study the process of transferring energy into non-thermal particles and the feedback to the environment? (in different phase-space regions)

➢ particle physics at highest energies

➢ self-purpose?

➢ connect the acceleration/interaction part with the propagation? (spheres of inference - detector/propagation/source)

→standard candle jump

TXS 0506 + 056

RS Ophiuchi

AT2018cow

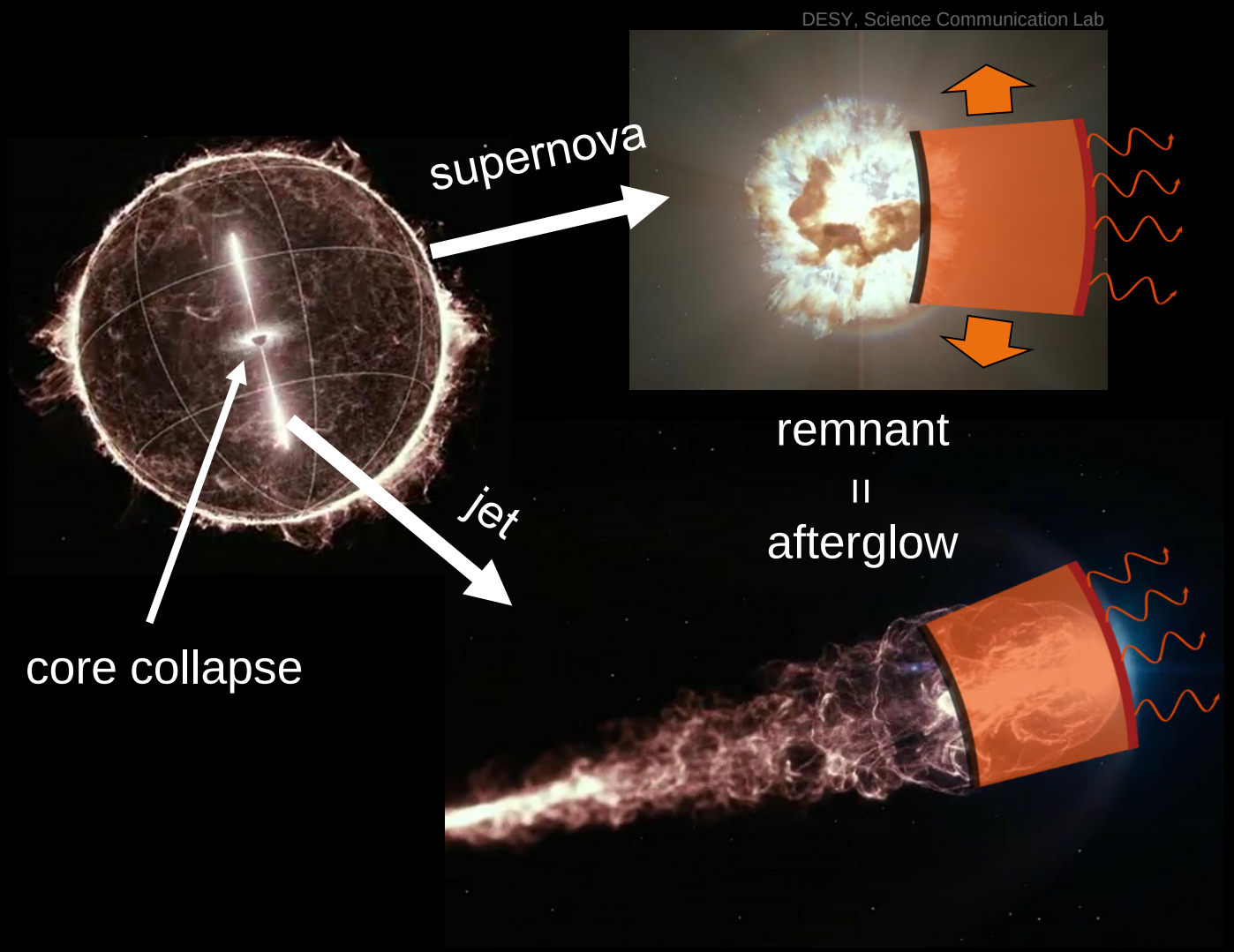
Transient spiral for different classes → where are we @ DESY

Bran Stark

GW170817

GRB190829A

Deaths of massive stars: SN and long GRB



- core collapse of massive star can free gravitational energy of star
- dump fast (rel. & non-rel.) outflow into surrounding medium

→ up to $E_{\mathrm{kin}} \approx 10^{51}\mathrm{erg}$

→ radial blast wave evolution at human time scales

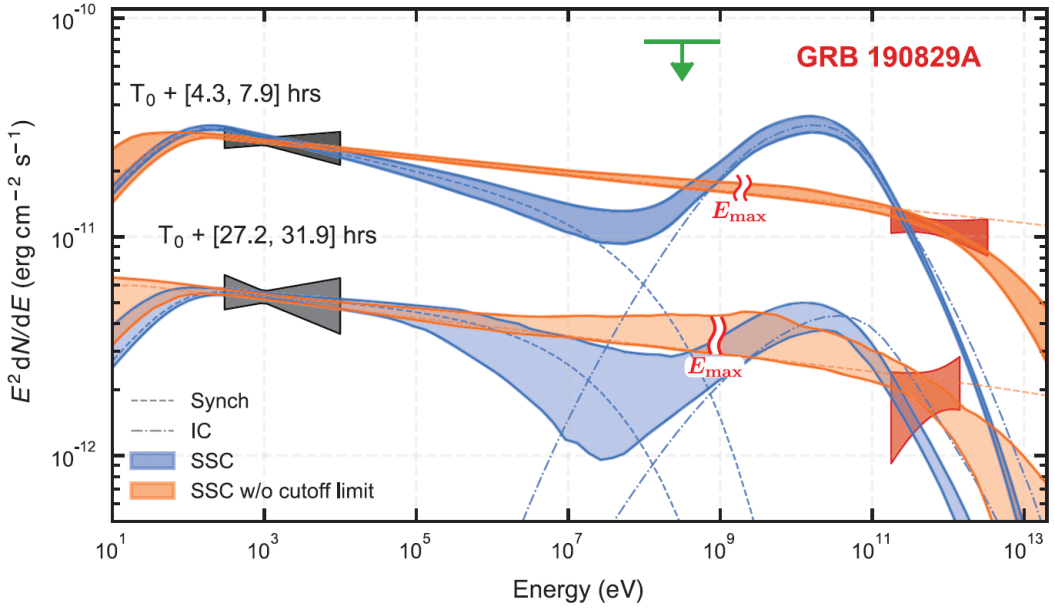
→ we can see a shock at work

→ 2 communities, 2 languages

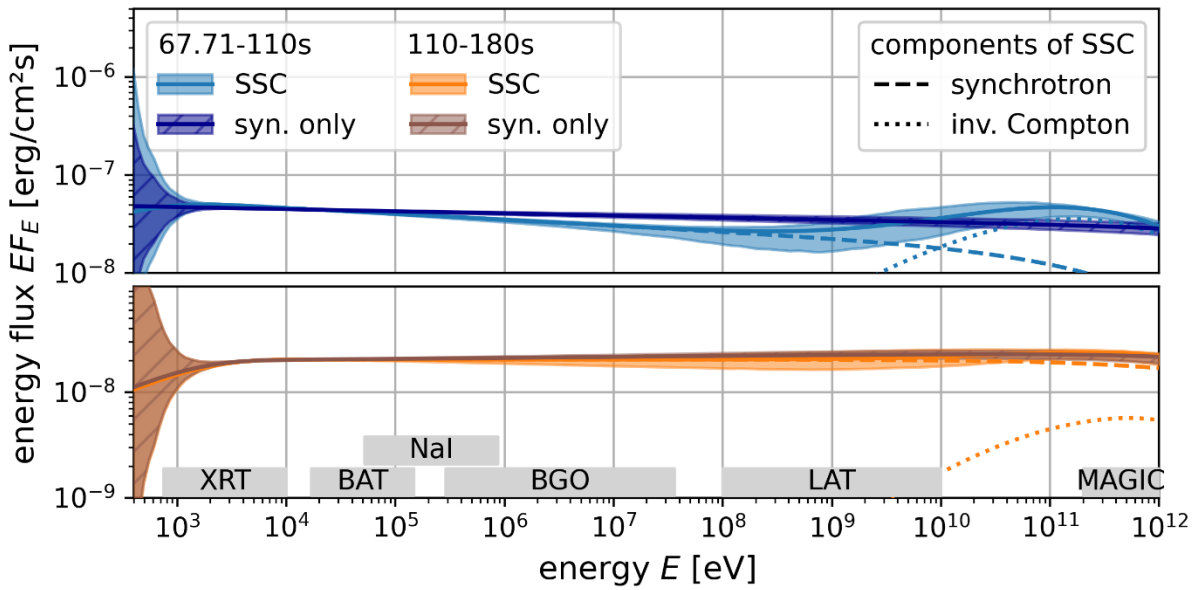
Long GRBs at VHE

- Collapse of rotating star → jet (GRB180720B, GRB190114C, GRB190829A, GRB221009A)
- Where can we learn the most? → keV-TeV window, neutrino ULs for hadronic scenarios?
- From VHE detection (2018): lower limit on particle energy (→ particle acceleration)
- From VHE spectrum (2019, 2022): place limits on some physical processes
- From contemporaneous keV-TeV spectrum: actual physical mechanisms

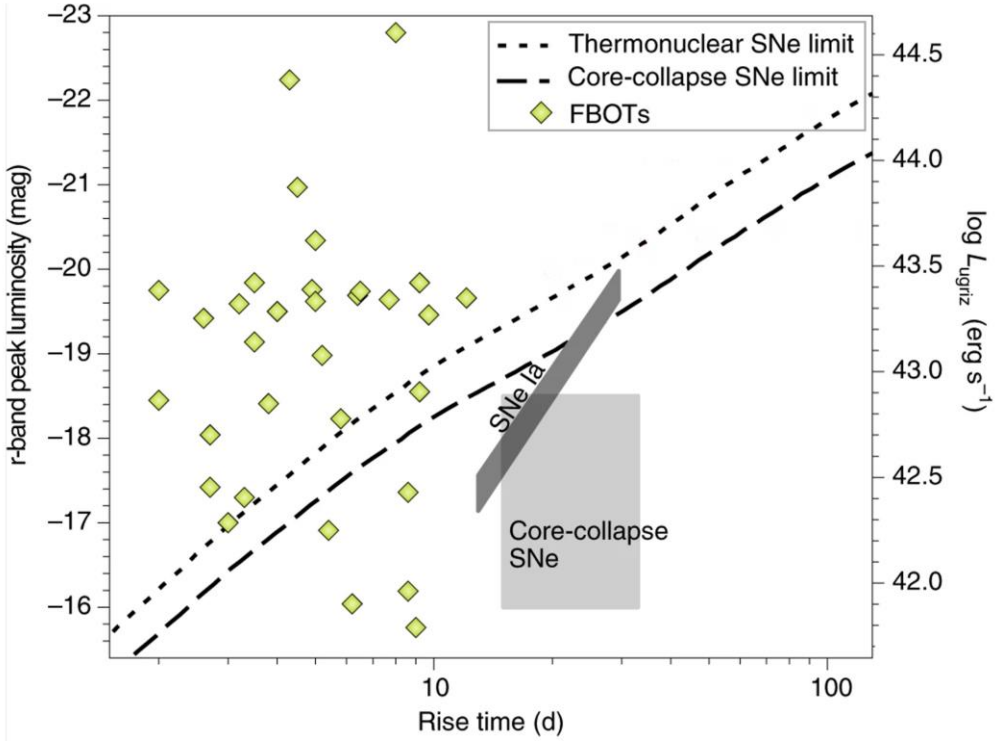
H.E.S.S. Science 372 (2021)



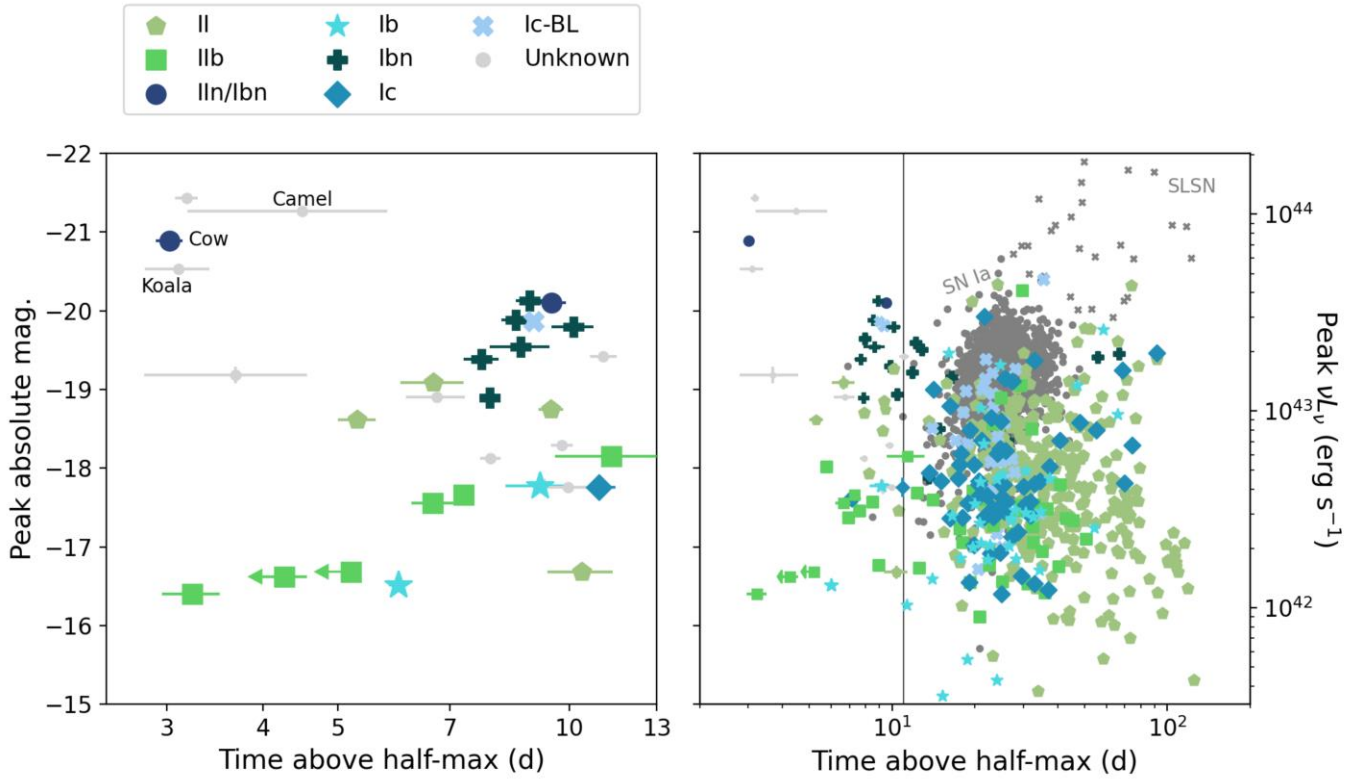
Klinger et al. MNRAS 520 (2023)



Fast Blue Optical Transients (FBOTs)



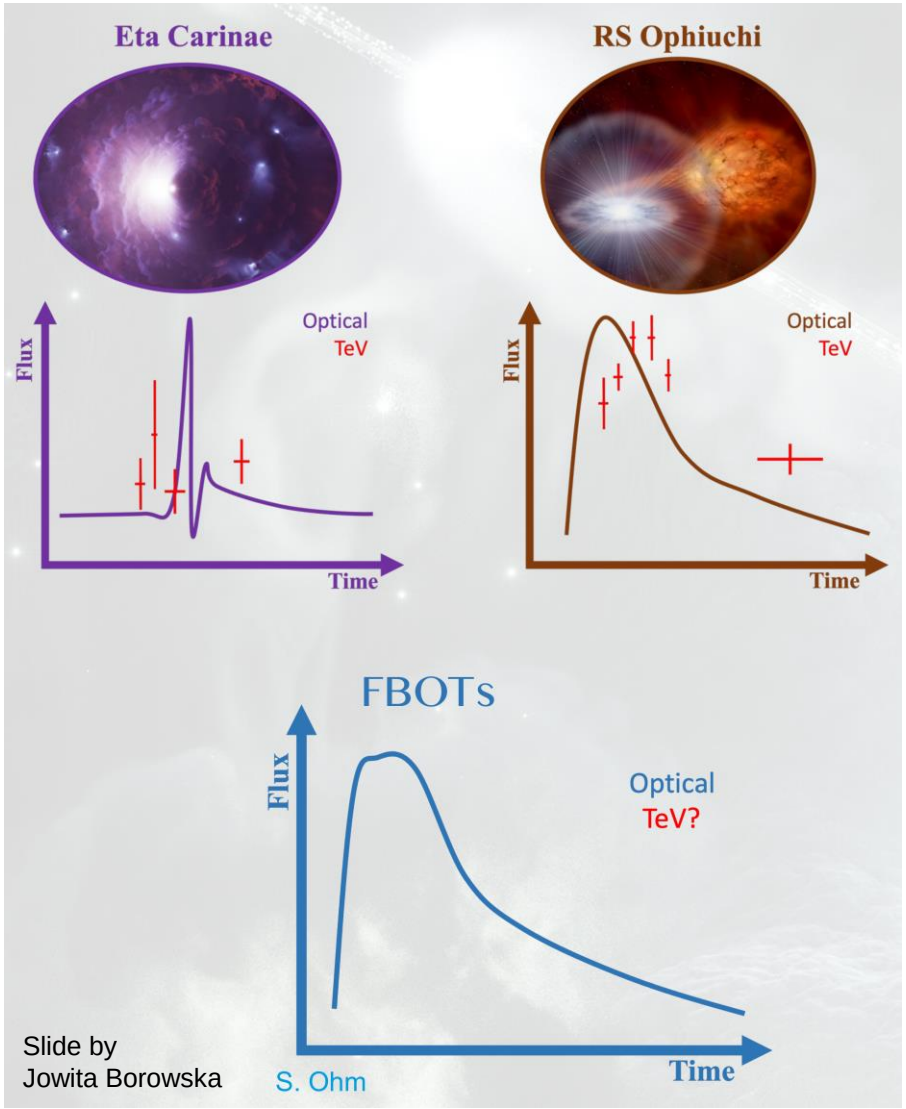
Inserra 2019



Ho et al. 2021

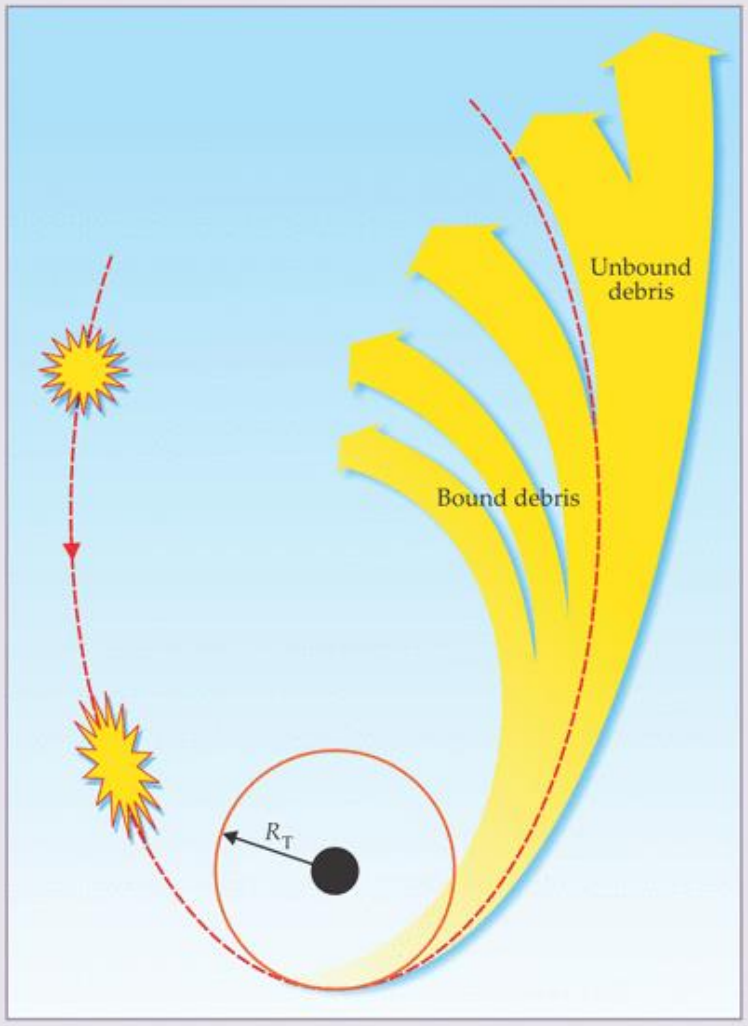
- Fast rising and falling, bright optical transients.
- Potentially exceptional interaction powered supernovae (type Ibn- and IIn-like).

Fast Blue Optical Transients (FBOTs)



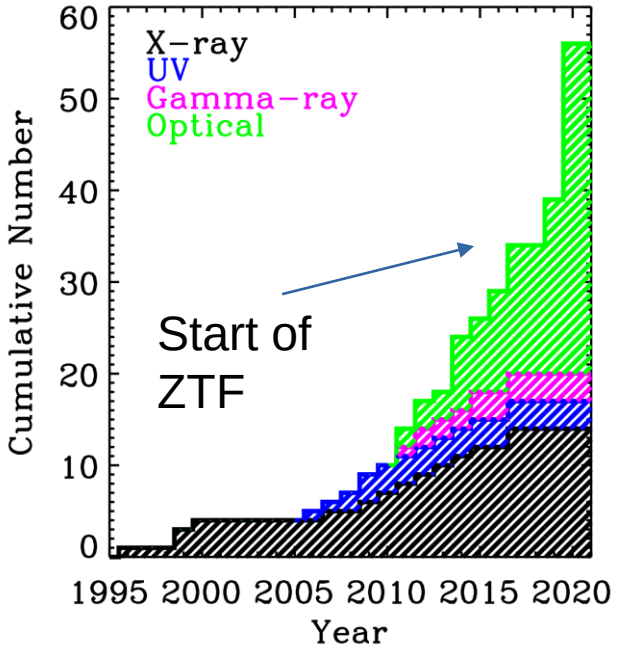
- Similar shock physics are seen in known hadronic time-variable sources such as Eta Carinae and RS Ophiuchi
- Follow-up interest in VHE gammas (@DESY H.E.S.S., Veritas), neutrinos?
  - Strategy simple; trigger as fast as you can.
- ToO alarm rate depends on optical surveys; (@DESY existing expertise with e.g. ZTF, AMPEL)
  - Current (ZTF) and future (LSST) large optical surveys are not optimal for FBOTs. Requires higher cadence surveys to catch the fast FBOT rise and fall.
- modeling: interest?

Tidal Disruption Events & non-thermal follow-up



Rees 1988

- Stellar object disrupted by tidal forces of a supermassive black hole
- Known hosts of particle acceleration (radio, X-rays, neutrinos)



Gezari 2021

- Maturing field in optical with increasing population → Model testing
  - Black hole spins, accretion physics, early universe black hole genesis

Tidal Disruption Events & non-thermal follow-up

- Non-thermal follow-up strategy is unclear (VHE gamma-ray perspective)
  - Non-thermal (jetted) TDEs are very rare.
    - ~5 jetted X-ray detections so far
    - 3 neutrino associations so far
  - Missing multi-wavelength data
    - No high cadence X-rays survey.
    - Radio results are not well disseminated.
  - Missing input from theory (this could be done in-house @DESY)
    - What are the best times to observe?
      - TDEs last for ~months, monitoring hard to justify for pointed instruments with seasonal observation programs
    - Can we base our trigger criteria on other wavelengths, e.g. IR ?

Questions to be adressed

- How to improve **communication**: more internal workshops? Collaboration private data vs DESY family? Prejudices?
- What is the **bigger goal**? Ideal coordination for science goals AND international competitivity? Inter-group projects with significant humanpower?
- strategy **transfer**: how can we advance one transient field from another? accumulate/outsource expertise DESY internal/external?
- Why **transients over *persistent*** sources? How to combine both best way?
- Which transient is **the best**?