The RAPTOR Telescopes:
Shaving off seconds can enable discoveries
GRB 050820a

Prompt Optical:

\[ F_p(t) = C_p F_\gamma(t) \]

Optical Afterglow:

\[ F_a(t) = C_a \left( \frac{t - t_0}{t_0} \right)^s \exp \left( \frac{-\tau}{t - t_0} \right) \]

\( C_p, C_a \equiv \) Component amplitudes
\( t_0 \equiv \) Onset of energy release
\( \tau \equiv \) Flux rise timescale
\( s \equiv \) Power - law decay index
Fast response enabled discovery of two components of GRB Optical Emission

- **Prompt Optical Emission** varying simultaneously with prompt gamma-rays. (Generated by photospheric emission or internal shocks in the GRB jet)

- **Early Afterglow Emission** that may start during prompt gamma-rays, but persists after gamma-rays fade.

- **Late Afterglow Emission** that can last for hours to days. (Afterglow is generated by external shocks---reverse shocks in the jet or forward shock in surrounding medium).
To study the prompt emission you need to respond fast. Typical duration ~60 seconds. BAT trigger latency ~20 seconds.

So you want to be on and observing in less than 10 seconds.

GRB durations measured by BAT.
Build for Fast Response:
Fully autonomous telescopes and enclosures

- Fast accelerating and slewing mounts (up to 100 deg/sec² and 100 deg/sec)
- Imaging anywhere in the sky in ~6-10 seconds
- Six ~0.4m class telescopes
- Simultaneous Multi-Color Imaging: g'r'i'z' Sloan Filters (RAPTOR-T)
- Fast Cadence system: 7 Hz (RAPTOR-Z)
- Will soon have Polarization measurement capability.

Persistent Monitoring:
- (3 locations in New Mexico, Maui, and Kwajalein)
- RQD2: Full Sky to 10¹⁵ R mag in 10s
"The Naked-Eye Burst" GRB 080319B

Prompt optical emission present
Onset lag?
GRB 130427A ---not all gamma-ray emission is prompt emission.

Summary of some key results--

• The first detailed comparison of an optical afterglow and the >100 MeV light-curve.
• The striking similarities between the optical light-curve and >100 MeV light-curve during first 7,000 seconds suggest co-generation in an external shock.
• Color changes in the afterglow and detailed modeling indicates generation by a reverse shock followed by the emergence of forward shock emission after about 3,000 seconds.
Important open observational questions about the prompt optical emission

• Is it polarized? How much and how does it evolve? This can help discriminate between Poynting-flux dominated jets and matter dominated jets with bright photospheric emission.

• What the relative timing of the prompt optical and gamma-ray components? ---Was the delayed onset in the “naked eye” burst real?

• What is color of the prompt optical and how does it evolve from pulse to pulse? How does the gamma-ray to optical flux ratio evolve?