Compact Binaries in the globular cluster NGC 6397

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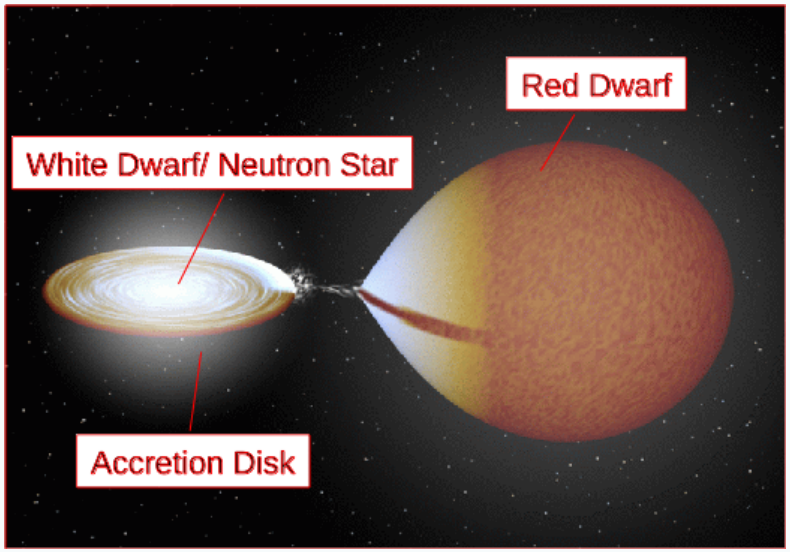
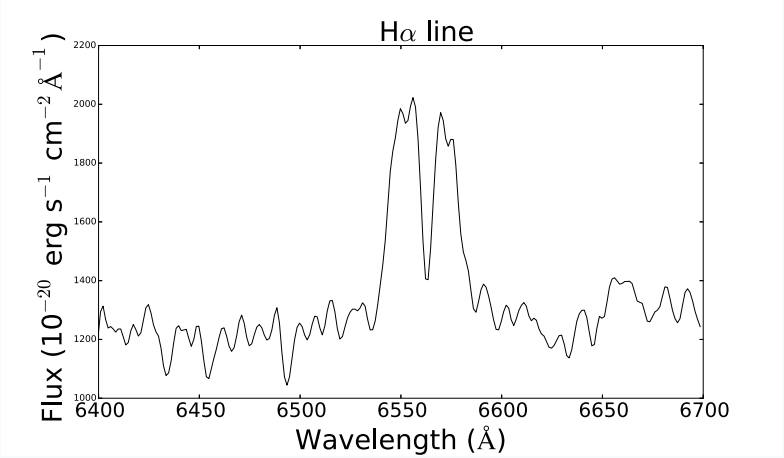
Compact Binaries

Cataclysmic Variable/ Low-mass X-ray Binary

- **White dwarf / Neutron star as primary:**
- MS star companion
- Accretion (usually) via a disk:
  - Disk instability outbursts. Increase several magnitudes



Credit: Rob Hynes.



Binaries in Globular Clusters

- **Globular Clusters**
  - The binary population drives the dynamical evolution of GCs
- **Cataclysmic Variables:**
  - Potentially very different from field CVs
  - A lot of open questions
- **Neutron Stars:**
  - Known distance binary in GC
  - Estimate equation of state (mass-radius relation)
- **Gravitational Waves:.**
  - White dwarf degenerate sources for LISA

Field CVs and GC CVs

GC CVs

- Primordial and Dynamically formed
- Dearth of outbursts
- Mainly magnetic?
- 8 spectra from 4 GCs
- Period distribution?

Field CVs

- Main Sequence binary evolution
- 40% show outburst
- 25% magnetic
- Hundreds of spectra
- $75\ \mathrm{min} \lesssim \mathrm{P_{orb}} \lesssim 10\ \mathrm{hrs}$

Lack data and understanding CVs in GCs

Binaries in NGC 6397

Known X-ray sources

- **Cataclysmic Variables**
  - 15 CV Candidates
  - Bimodal Population:
    - Bright and Faint (Cohn et al. 2011)
- **Millisecond Pulsars (MSPs):**
  - One radio confirmed and one candidate
- **Neutron Stars:**
  - One qLMXB and possibly ultracompact

Characterize and find new binaries

MUSE

Integral Field Unit (IFU)

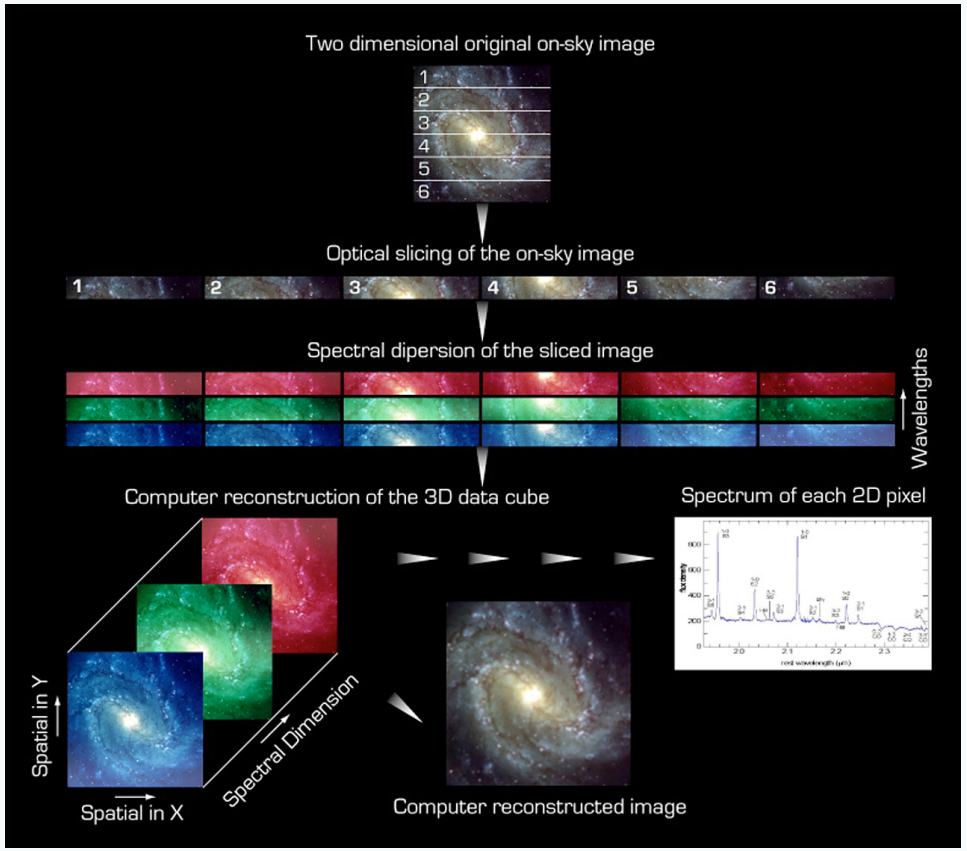
- **Data cube:**

  $\mathrm{FoV}: (1' \times 1')$

  $(0.''2 \times 0.''2 \times 1.25\,\text{Å})$

  $4800 - 9300\,\text{Å}$

- MUSE Commissioning
  - July 26th to August 3rd, 2014
  - Very short exposures (25-60 s)
  - Total 95 minutes



Credit: ESO

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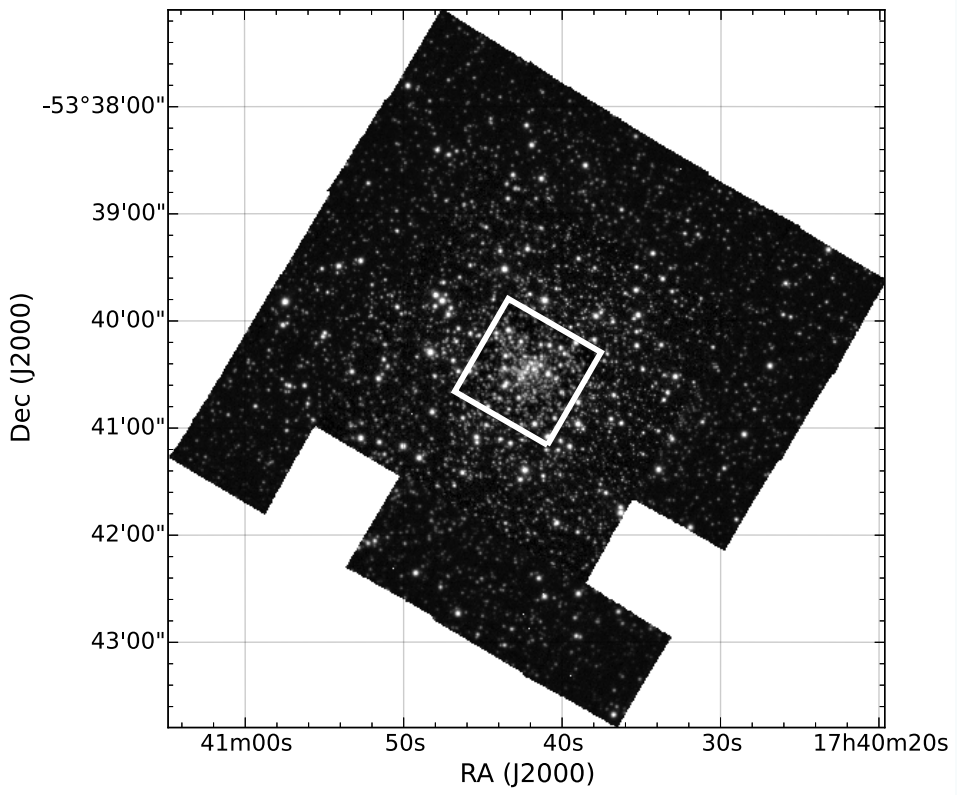
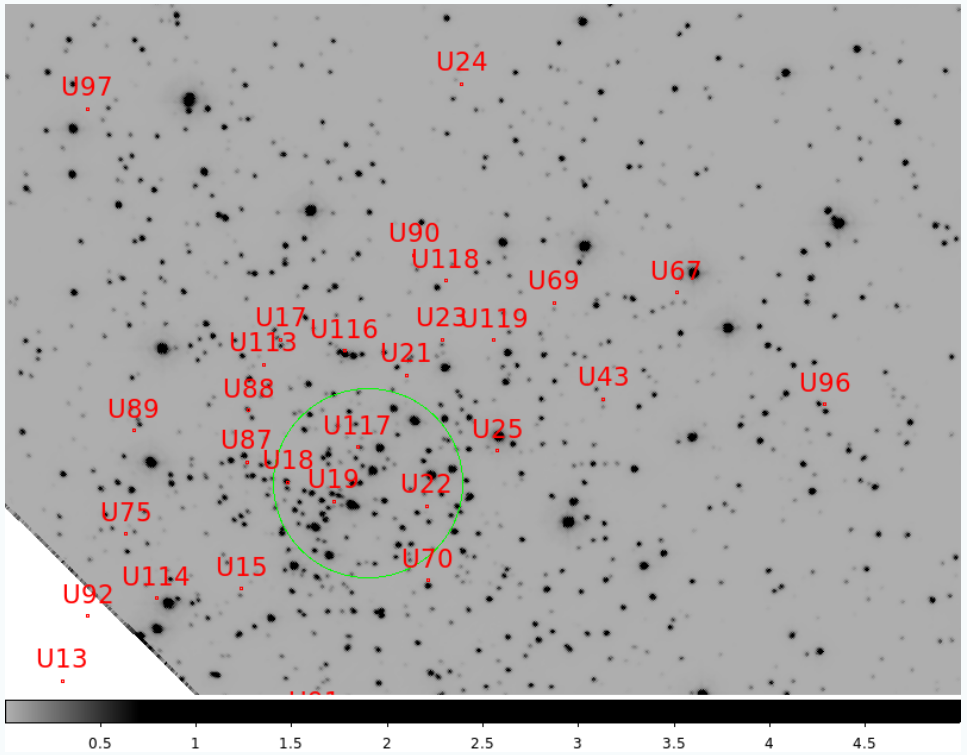


Credit: ESO

Hubble Space Telescope

Wide Field Planetary Camera 2

- March-April 2005:
  - 126 Orbits
  - F814W, F606W and F336W
  - Exp time:500-700 s



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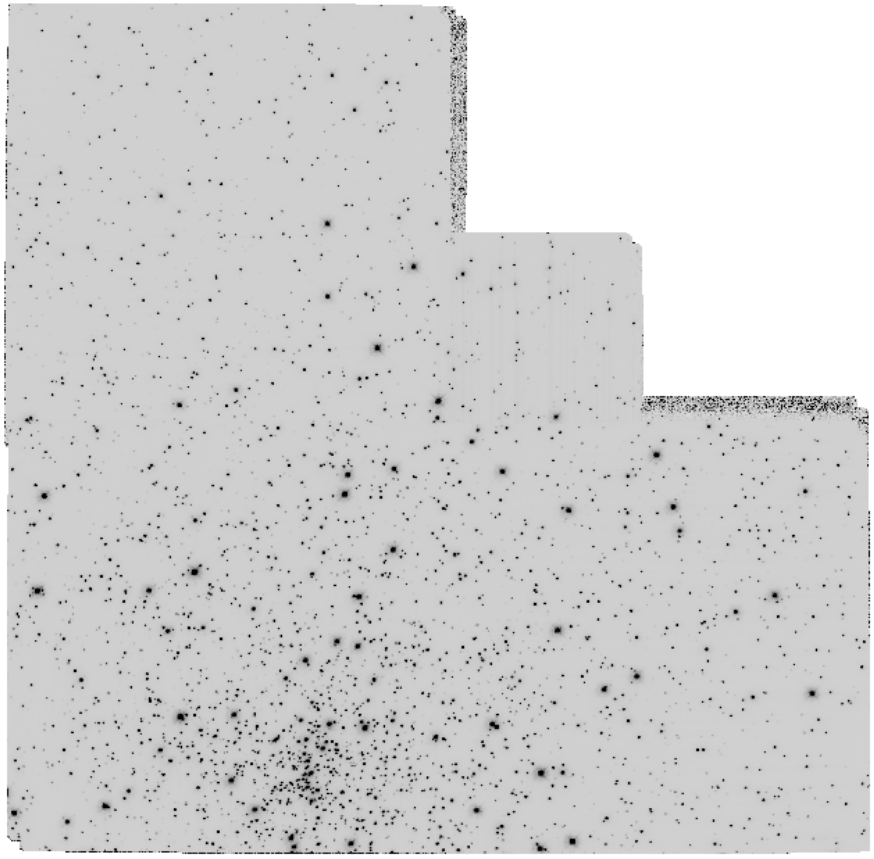
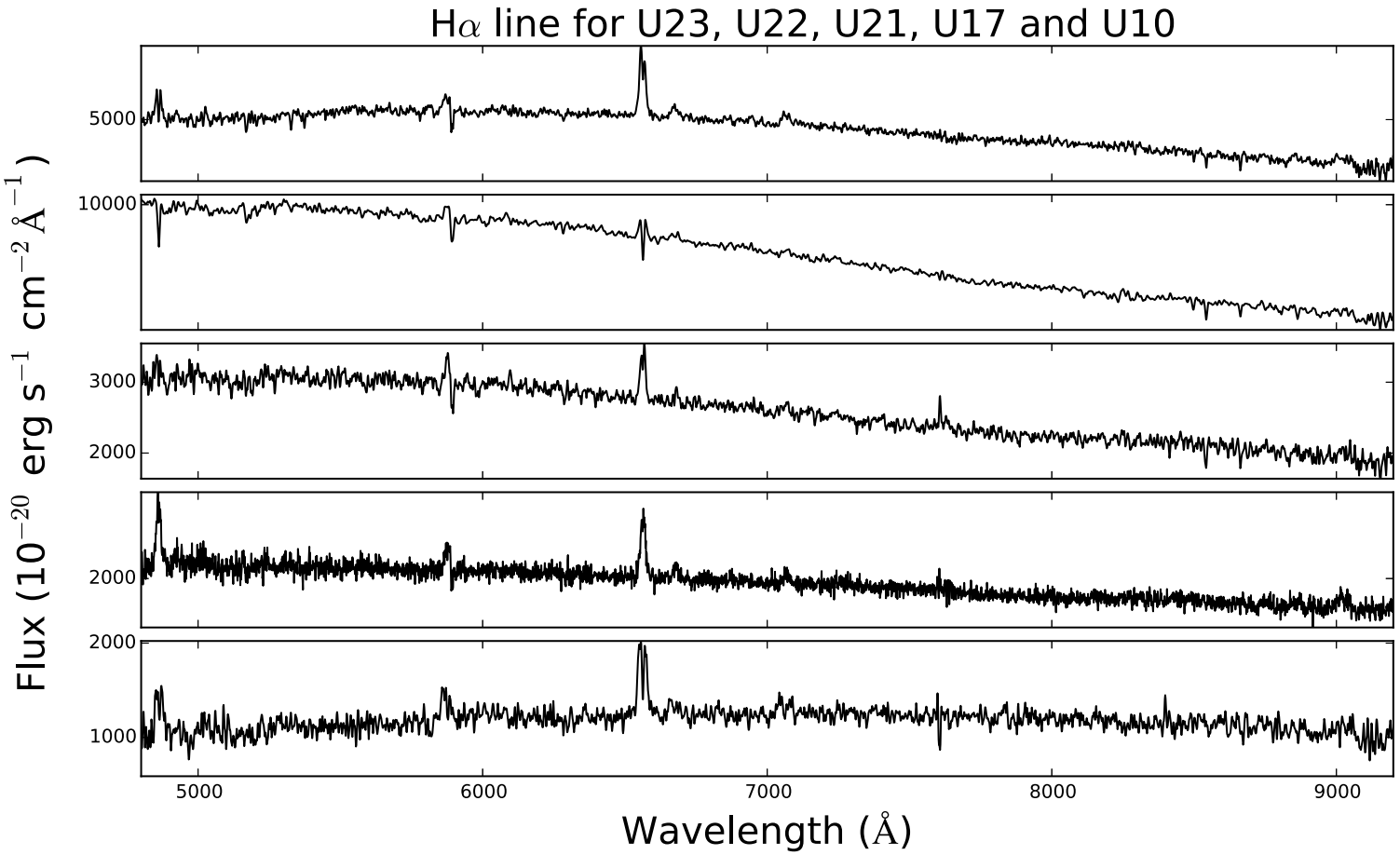


Credit: NGC 6397

Detected CVs



Obtained spectra from CVs in NGC 6397. IDs from (Bogdanov et al., 2010)

Compact Binaries in NGC 6397

ID	Location	Reference	Comments
U17	core	(1)	CV HST opt
U19	core	(1)	CV HST opt
U23	core	(1)	CV 11 h period (3) Sub-subgiant ?
U21	core	(2)	CV HST opt
U22	core	MUSE	CV
U10	outskirts	MUSE	CV Known period (3)
U12	core	MUSE	MSP
U18	core	MUSE	MSP? known period?

(1) Grindlay et al. 1995; (2) Edmonds et al. 1999; (3) Kaluzny & Thomson 2003

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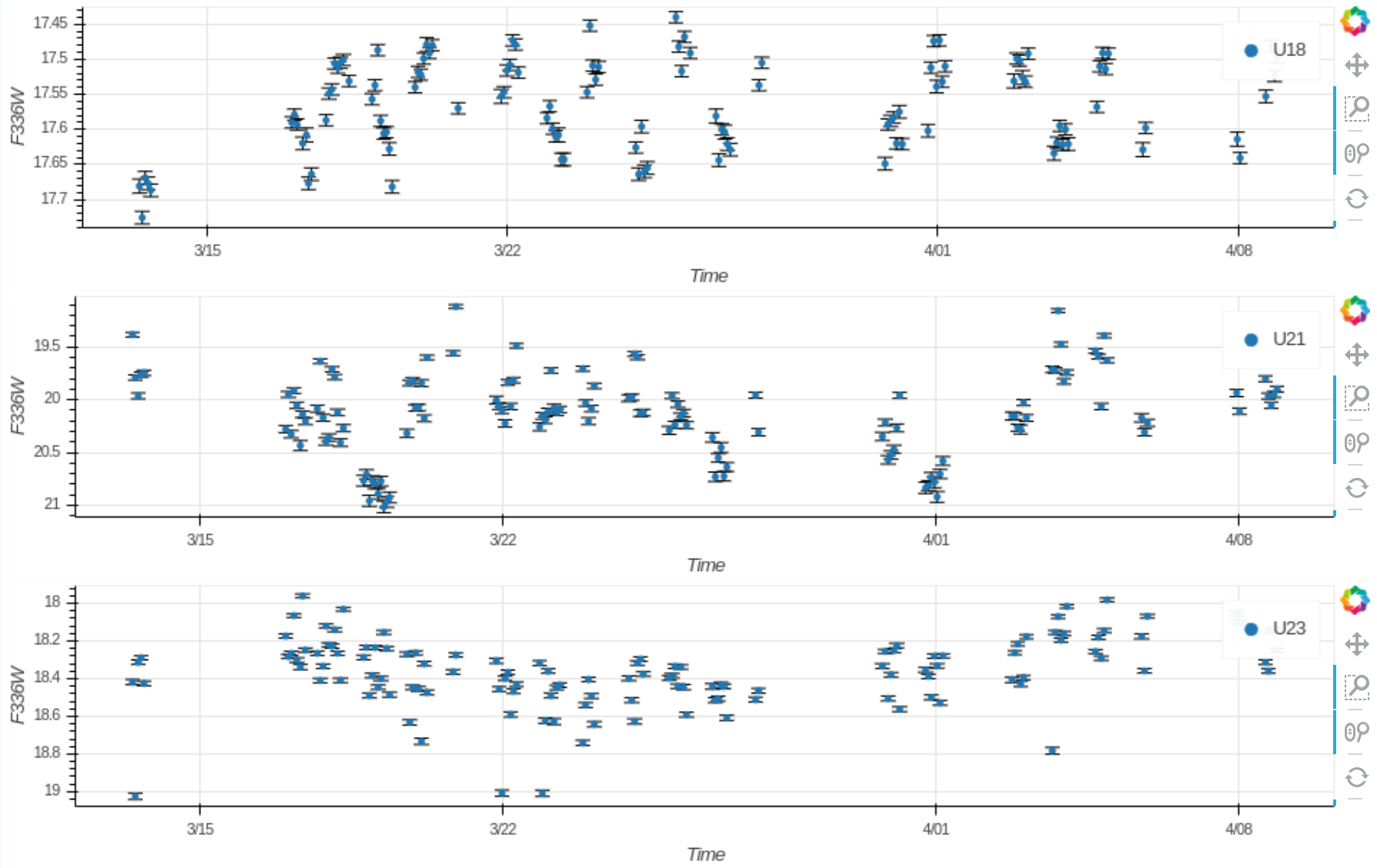
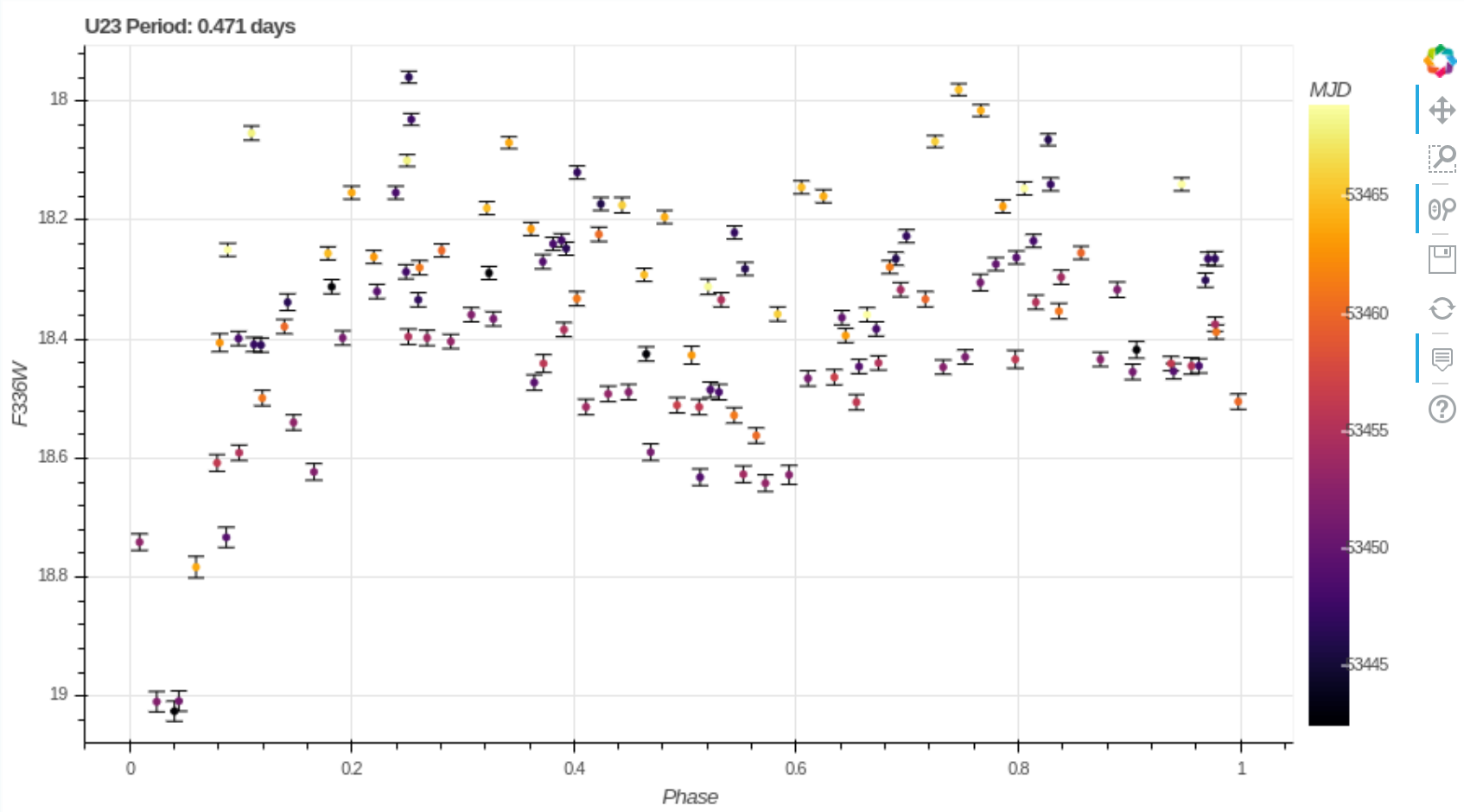
Light Curves



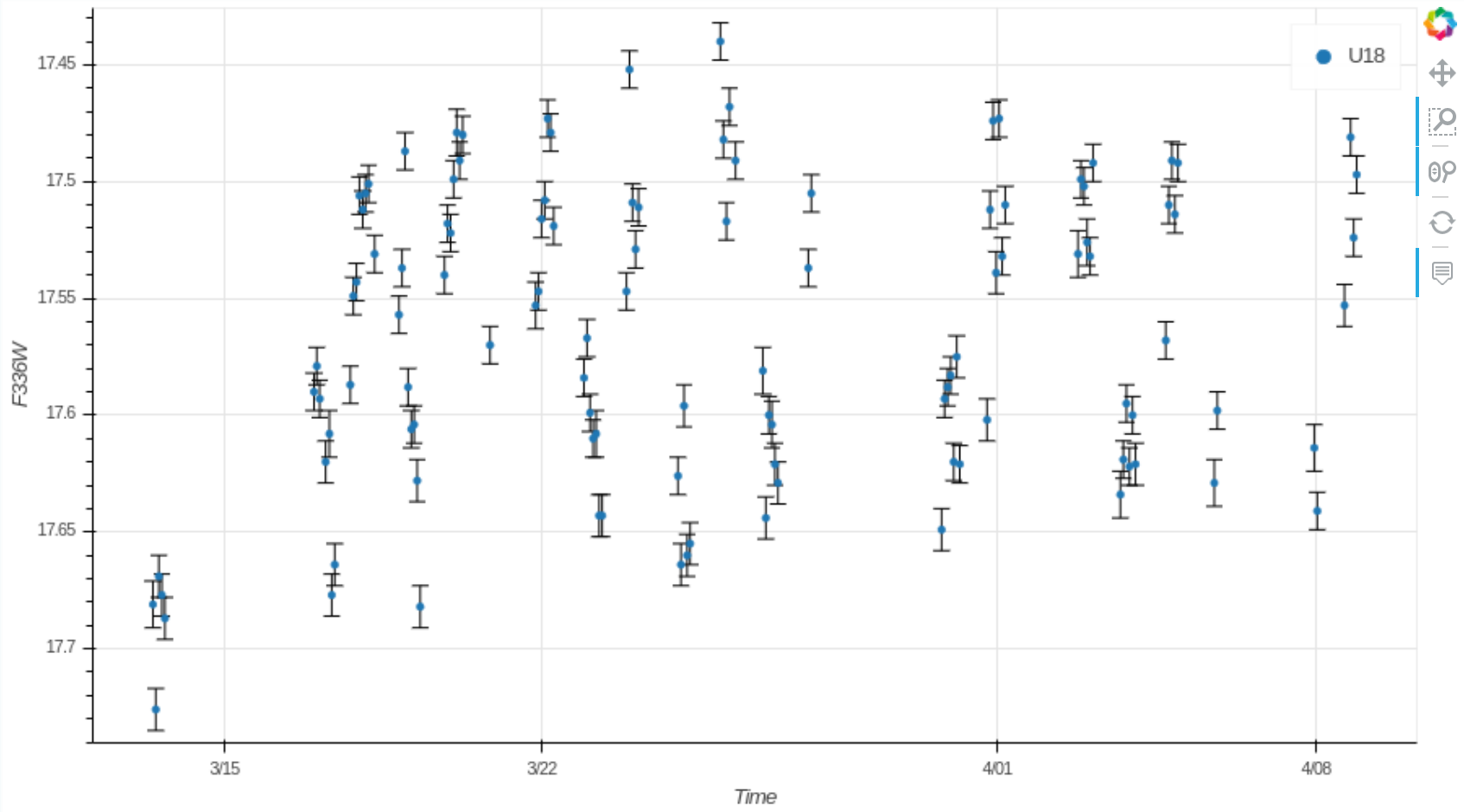
CV1

Kaluzny et al. (2006) reported period of 0.471 days



U18

Candidate MSP. Possible redback system.



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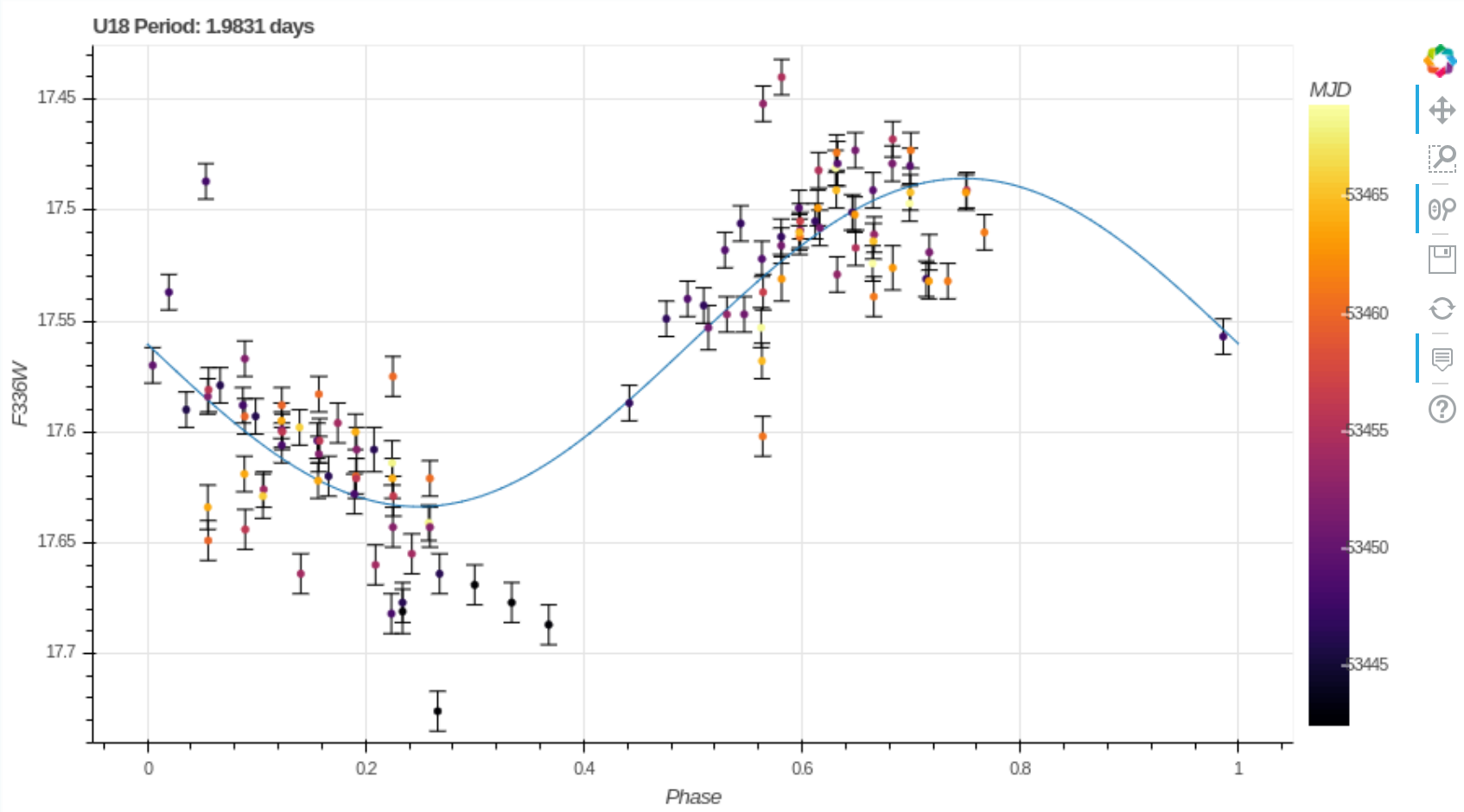


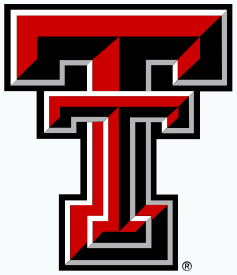
Future Work

- **Follow up Observations**
  - MUSE Adaptive Optics and extended range
- **Variability:**
  - Find more periods
- **Datacube:**
  - Systematically search for emission:
    - Helium emitters (AM CVn ?)
    - Planetary Nebula
    - Active Binaries

Conclusion

An IFU like MUSE and archival data by HST can be used to efficiently study the population of compact objects in globular clusters.

Gracias



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