

## DIVISION B / WORKING GROUP TIME DOMAIN ASTRONOMY

CHAIR

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ORGANIZING COMMITTEE

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### TRIENNIAL REPORT 2018–2021

#### 1. Motivation for the Working Group on Time Domain Astronomy

The IAU Working Group on Time Domain Astronomy promotes the study of variability - transient, periodic, secular, or aperiodic - across all disciplines of astronomy from the solar system to cosmological distances. In keeping with the broad scope of activities, WG members represent a diversity of topics including synoptic surveys in all bandpasses, multi-messenger follow-up, stellar variability, moving objects, heritage data, instrumentation, robotic telescopes, communication, analysis, and education. Thus we provide a forum to bring together specialists who may not interact very frequently, if at all, providing a basis for exploring commonality in data analysis tools, simulations, standards, observing strategies, transient alert infrastructure, telescope scheduling, etc. In particular, we support meetings such as 2017's IAU Symposium 339, *Southern Horizons in Time Domain Astronomy*, and the ongoing workshop series *Hot-wiring the Transient Universe*.

#### 2. Proposal to continue the Working Group on Time Domain Astronomy for 2021–2024

The time domain reaches into almost all corners of astronomy, so the ultimate goal for this group may be a cross-division commission to be proposed again at a future General Assembly, but for 2021 we propose the Division B Working Group on Time Domain Astronomy continue for the next triennium. However the group is organized, we welcome collaboration from all institutions and individuals on both the science and infrastructure of time-varying phenomena of all kinds.

#### 3. History

The first discussions of forming an IAU working group on the astronomical time domain occurred during the highly successful symposium *New Horizons in Time Domain Astronomy*, IAUS 285 that was held in 2011 at the University of Oxford. This resulted in a proposal to form a new IAU Commission on the Time Domain that was submitted as part of the IAUs major effort leading up to the 2015 General Assembly to restructure its several commissions. Though widely supported, this proposal was not among those adopted, at least partially due to the extremely broad nature of time domain astronomy that created difficulty in finding the right home among the IAUs divisional structure.

It was thought best to focus on converting the proposal from a commission to the

working group level, and Commission 5 seemed a good home. Commission 5, nominally Data and Documentation, but also the home of software efforts such as the International Virtual Observatory Alliance and FITS, was already the venue for many time domain activities. We are grateful for the generous support the TDA Working Group received from Commission 5 and then from its successor, Commission B2, during the several months of the Working Groups existence at the Commission level.

Shortly following the 2015 General Assembly we proposed restructuring the Working Group at the divisional level under Div-B which broadened its reach to Facilities, Technologies and Data Science. Approval from the Executive Committee was secured by November 18, 2015, and further activities such as the proposal for what became IAU Symposium 339 have been pursued as a divisional working group.

#### 4. Activities of IAU Division B WG Time Domain Astronomy during 2018-2021

Working Group activities during this period included organizing *Hot-wiring the Transient Universe VI* workshop in 2019 with international participation. The working group also provides a mailing list for announcements and discussions pertinent to time domain astronomy. Membership of the TDA WG currently numbers 114.

The first *Hot-wiring the Transient Universe* meeting was organized as a joint workshop of the Virtual Observatory and of the Heterogeneous Telescope Networks consortium and was held in 2007 at the University of Arizona. Meeting roughly every two years, scientists and engineers involved in projects carrying out time domain astronomical observations have the opportunity to wrestle with the complex and intertwined requirements of synoptic science. Time domain astronomy is at the fore of modern astrophysics and crosses fields from solar physics and solar system objects, through stellar variability, to explosive phenomena at galactic and cosmological distances.

*Hot-wiring the Transient Universe VI* was held at Northwestern University, 19-22 August 2019 (<https://sites.northwestern.edu/hotwired6>). Ninety-three participants from about a dozen countries presented on numerous topics over four plenary days, plus another day of breakout sessions. The meeting rationale was to explore opportunities and challenges of massively parallel time domain surveys coupled with rapid coordinated multi-wavelength follow-up observations. The interdisciplinary agenda included: 1) future and ongoing science investigations, 2) information infrastructure for publishing observations in real time, 3) novel data science to classify events and systems to optimize follow-up campaigns, and 4) hands on activities to train on alerts from current surveys and broker systems.

Given the success of Hotwired VI under the umbrella of the TDA Working Group, we were in the process of organizing Hotwired VII to be hosted in 2021 at Pennsylvania State University when the COVID-19 pandemic occurred. We look forward to continuing the Hotwired workshops in person after academic travel resumes, hopefully in 2022. Hotwired VI included multiple talks that were delivered remotely and undoubtedly this option will be expanded, indeed remote presentations were featured at the first Hotwired meeting in 2007, however, we feel the highly technical nature of these workshops benefit from face-to-face interactions and hack days.

## 5. The future

A pace of 2-3 workshops with attendance up to about one hundred, versus an occasional larger symposia seems about right for the TDA Working Group each Triennium. We will also continue discussions with the American Astronomical Societys WG-TDA to identify and develop opportunities for collaboration. The next few years will see the broad adoption of event brokers, with projects like ANTARES and Lasair for stationary transients and NEOfixer for moving objects in the solar system defining key infrastructure for their respective communities in support of large surveys like the Zwicky Transient Factory, the Large Synoptic Survey Telescope, Pan-STARRS, and the Catalina Sky Survey, as well as similar functionality for investigator-driven time domain projects of all descriptions. These projects must be tied together by community-adopted standards and protocols such as VOEvent, JSON, and ADES. The TDA Working Group will engage with the community to ensure wide adoption of core standards in pursuit of closing the event loop between celestial transient events and robotic follow-up.