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A Python API for OTTER

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Summary

The Open mulTiwavelength Transient Event Repository (OTTER) is a new catalog of published transient data. Here we present a thick Python wrapper on the Representational State Transfer (REST) application programming interface (API) built-in to the OTTER backend database (the "OTTER API"). Since the OTTER backend is built on the document database ArangoDB, using the REST API directly requires learning the Arango Query Language (AQL). Since AQL has a niche user base, OTTER users unfamiliar with it may face a roadblock to programmatic access of OTTER. To overcome this barrier, we created the OTTER Python API to make programmatic access easy and fast. In addition to wrapping the REST API, the OTTER Python API also provides additional methods for converting the stored photometry to standard units; helper methods for querying additional astronomy database services; and methods for quickly plotting the photometry stored in OTTER.

Statement of need

Transient astrophysical events provide a unique high-energy laboratory that evolves on human timescales. Examples include supernovae, gamma-ray bursts, tidal disruption events, and many other exotic transients (Colgate & White, 1966; Eichler et al., 1989; Heger et al., 2003; Hills, 1975; Kouveliotou et al., 1993; Maoz et al., 2014; Narayan et al., 1992; Norris et al., 1984; Rees, 1988; Smartt, 2009; Woosley & Weaver, 1995). Developing an understanding of the many astrophysical transients observed is not easy and typically requires detailed multiwavelength observations and analyses of the population of events (Alexander et al., 2025; Christy et al., 2024; Costa et al., 1997; Eftekhari et al., 2018, 2021; Gezari et al., 2017; Gomez et al., 2024; Guolo et al., 2024; Hajela et al., 2025; Laskar et al., 2022, 2023; Margutti et al., 2023; Masterson et al., 2024; Olivares E. et al., 2015; Pasham & Velzen, 2018). However, it can take years to gather the multiwavelength datasets from the literature, necessitating publicly available transient event data archives.

Furthermore, transient classification is a non-trivial process that typically requires detailed spectroscopic and/or multiwavelength follow-up observations (e.g., Arcavi et al., 2014; Charalampopoulos et al., 2022), a method that is only feasible with the current transient discovery rates. With the advent of Rubin Observatory's Legacy Survey of Space and Time (Ivezić et al., 2019) the number of known transients will increase by at least an order of magnitude (Bricman & Gomboc, 2020; Velzen et al., 2011). Therefore, additional methods for classifying transients, such as machine learning, are required (Boesky et al., 2025; Gomez et al., 2020, 2023; Soto et al., 2024; Stein et al., 2024; V. A. Villar et al., 2019; V. Ashley Villar et al., 2020, 2021). However, machine learning classifiers require large training datasets that can be laborious to curate. This further motivates archival services for cataloging transient metadata and photometry, and will be necessary to maximize the scientific output of the Rubin time domain survey.

For both of these reasons we created the Open mulTiwavelength Transient Event Repository (OTTER, Franz et al., 2025), a scalable catalog of transient event metadata and photometry. OTTER is a successor to the Open Astronomy Catalogs (OAC, Auchettl et al., 2017; Guillochon et al., 2017),[1] but designed and optimized for multiwavelength datasets. To store the various nuances of multiwavelength photometry (e.g., the model used to reduce and extract a flux from an X-ray observation), we chose to use a flexible document database management system as our backend: ArangoDB. The nested structure of the document database files also provides an intuitive way to store multiple values of a single measurement when different sources disagree.

One of our primary goals of OTTER is ease of access to the dataset, including a way to programmatically access it to make the curation of large transient samples easier. ArangoDB has a built-in REST API for programmatic access to the data. However, the API endpoints expect queries in the syntax of the ArangoDB Query Language (AQL). Learning a new query language creates a barrier for programmatic access to the indispensable dataset available in the OTTER catalog.

To help overcome this barrier, we present a Python API for access to the OTTER dataset. This API acts as a thick wrapper on the AQL-based API, with many additions that make it easier to access and analyze the dataset. Some of these features include:

- In OTTER we store photometry as close to the actual published value as possible to make the data more reproducible. However, this also means that the data is not stored in consistent units (but the unit of the photometry point is stored). In the OTTER API we automatically convert the photometry into the user-requested units. Specifically, the conversion is done in the `Otter.get_phot` and `Transient.clean_photometry` methods which use Astropy (Astropy Collaboration et al., 2013, 2018, 2022) and synphot (Team, 2018).
- The same raw data from an astronomical observation may be reduced[2] by multiple, distinct, teams. Depending on the differences in the reduction methodology this may produce different flux measurements. If this is the case, we store both flux measurements in the OTTER database to allow the user to choose their preferred reduction. However, to help users de-duplicate these datasets while curating large samples, we provide an (optional) automated algorithm for finding duplicates and choosing only one of the multiple reductions. This is done in the `Transient.deduplicate_photometry` method.
- Sometimes users want to quickly view the photometry for a specific transient event as either a light curve (flux as a function of time) or a spectral energy distribution (flux as a function of wavelength, frequency, or energy; i.e., an SED). In the `plotter` module of the OTTER API we provide numerous methods for quickly and automatically plotting the photometry (Hunter, 2007; Inc., 2015).
- Identifying the host galaxy of a transient event can be difficult and it is important to store identifying information (e.g., name and coordinates) for a host galaxy, if it is known. However, there are numerous existing astronomical databases that store galaxy properties and we do not want to duplicate their efforts. We therefore provide methods as part of the `Host` object to query other public services for host photometry or spectra. These other services include SIMBAD (Wenger et al., 2000), ATLAS (Tonry et al., 2018), ZTF (Velzen et al., 2019), iPTF (Blagorodnova et al., 2017), ASAS-SN (Hart et al., 2023; Kochanek et al., 2017; Shappee et al., 2014), VizieR (Ochsenbein et al., 2000), WISE (Hwang & Zakamska, 2020; Mainzer et al., 2011, 2014; Wright et al., 2010), FIRST (White et al., 1997), NVSS (Condon et al., 1998), HEASARC, and Sparcl (Juneau et al., 2024) — most of which are queried using the Astropy-affiliated `astroquery` package (Ginsburg et al., 2019).
- Users may want to compare new observations stored locally with the publicly available

[1] The OAC was an indispensable resource but has not been maintained since 2022, further necessitating a successor like OTTER.

[2] By "reduced" we mean that the proper calibrations are applied and a flux, flux density, or magnitude is extracted from the raw data.

data in OTTER. As part of the OTTER API we make this very easy as long as their data is stored in a well-documented CSV file format (see the OTTER web application upload form or the example Jupyter notebook titled "Interfacing with Private Data"). When the data is stored like this a user is able to use the `Otter.from_csvs` method to construct an `Otter` object that will pass their queries to both the public OTTER dataset and the one locally stored and return all relevant information in a consistent format.
- We allow for the storage of different measurements (e.g., redshift, discovery date, etc.) associated with the same property of the transient. The OTTER API will automatically choose a default value if multiple measurements are present for a single property.

Software impact and conclusions

Moving forward, OTTER, in its entirety, will be a useful infrastructure tool for time domain science. Even more, the OTTER API described here will make access to that dataset easier for users by lowering the API learning curve. Evidence of this is the impact of the Open Astronomy Catalogs, which have > 500 citations (Guillochon et al., 2017) and is still used today, despite being deprecated.

There are already multiple astronomers using the software for their research, spanning from undergraduate students to faculty. There are currently two papers citing OTTER (Alexander et al., 2025; Christy et al., 2025) and at least another in preparation (Farley et al., in prep.). Additionally, our immediate research groups have already used OTTER for writing successful telescope observing proposals. We presented this work at the Kavli Institute for Theoretical Physics: Towards a Physical Understanding of Tidal Disruption Events session, Astronomical Data Analysis Software and Systems: 2025 Monsoon Workshop, and the 2025 X-ray Quasi-Periodic Eruptions and Repeating Nuclear Transients Conference. It was positively received at all of these conferences and we accrued ~ 15 beta testers who provided invaluable feedback. We welcome GitHub issues with comments and feedback (or even pull requests!) from the community on our GitHub repository.

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