IVOA Spectral Energy Distribution (SED) Data Model

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IVOA Note

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http://www.ivoa.net/Documents/TBD

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Abstract

We present a data model for Spectral Energy Distributions (SED) by extended the existing IVOA Spectrum data model.

Status of this document

This is a draft for discussion among the relevant VAO and IVOA working groups.

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The **Virtual Observatory (VO)** is general term for a collection of federated resources that can be used to conduct astronomical research, education, and outreach.

The **International Virtual Observatory Alliance (IVOA)** (http://www.ivoa.net

) is a global collaboration of separately funded projects to develop standards and infrastructure that enable VO applications.

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Part 1: SED Data Model

1 Introduction and Motivation

The IVOA has identified creation and analysis of spectral energy distributions as a key science capability desired in the VO. In this document we present a proposed abstraction for spectral energy distribution data and serializations in VOTABLE and FITS for use as a standard method of SED data interchange.

1.1 Change Log

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2010 Nov 4  Initial draft.
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2 Spectral energy distributions

A spectral energy distribution (SED) represents the energy output of an astronomical source over a wide spectral range. It differs from a traditional astronomical spectrum in that it is a composite data set which may be derived from (or in the case of a model SED, compared to) multiple instruments, telescopes and observational epochs.

Individual observations which go into the creation of an SED may be single photometry points or 1-D spectra with flux values at many spectral coordinates. Each of these observations has its own metdata describing the observational conditions, etc. We refer to these individual observations as **segments**.

We distinguish two main varieties of SED:

- an **aggregate SED**, consisting of a logical collection of segments together with each segment's metadata; no attempt is made at this stage to reconcile the data in the different segments.
- a **uniform (or rebinned) SED**, consisting of a single merged segment. To go from an aggregate SED to a binned SED requires rebinning the data on a fixed wavelength or frequency grid and handling overlaps (for example, you may have a V photometry point overlapping an optical spectrum, or multiple V photometry points at different times).

Some SED science is done with uniform SEDs, which are the simplest to handle; some science requires you to work with the aggregate SED directly. This is the usual methodological dichotomy in astronomy between correcting your data to compare directly with a model, or folding your model through a simulation of the observation process and comparing the result with the data. Both kinds of SED may therefore have model (theoretical) counterparts, but we normally think of a model SED as being of the uniform kind.

One can also have an SED described by an analytic function; we consider this to be outside our scope, and assume that such representations will be instantiated as a finite, discrete array of flux and spectral coordinate values.

One special case is worth mentioning: a light curve consists of photometry points in the same band but at different epochs; this is a valid example of an aggregate SED, but if all the points are taken with the same instrumental conditions (same metadata except for time) it can be treated in similar ways to a uniform SED.

2.1 Scope

In modern instruments, photometry and spectra are often obtained by extraction from two- or higher-dimensional detectors; photometry points from CCD images, spectra from long slit images, echelle datasets and spectra data cubes. The process of reducing such data to simple sets of flux-versus-spectral-coordinate arrays is out of our scope; we are only attempting at this stage to describe the extracted data, usually in calibrated form.

3 SED Data Model summary

Our fundamental SED data model as follows:

1. An SED is an aggregation of 'segments'.

2. Each segment is either a photometry point, a light curve (time-resolved photometry points in a single band) or a spectrum.

3. A spectrum is described by the IVOA Spectrum data model.

4. A photometry point or light curve is described by the IVOA Photometry data model.

The uniform SED is a single Spectrum instance; its metadata refer to the combined data points. For some use cases it is useful to be able to link to the individual segments of the aggregate SED from which the uniform SED is derived. This is a difficult problem, since a single point in the uniform SED may be a complicated function of points from multiple segments in the aggregate - either time averaging of photometry, or combining overlapping spectral segments and/or photometry points. Instead, we include a URI pointing to the aggregate SED as a whole. One would also like to record the algorithms used to create the uniform SED but this is beyond the scope of the current standard.

4 Serialization

We define two serializations of the SED data model: FITS and VOTable.

4.1 Aggregate SED

In each case, our approach is to use the VO Spectrum and Photometry serializations for each segment and to aggregate the segments.

4.2 Uniform SED

The uniform SED is serialized according to the VO Spectrum data model, with the additional optional metadata pointing to the aggregate SED from which it is derived:

- SED.Aggregate - URI to aggregate SED. FITS keyword SED_ORIG.