Shape 2010

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Why Shape?

Images inspire us. Images lead to ideas.

We made Shape as a tool to quickly test inspirations. Play "True or False". By showing whether an idea works or not, either way, Shape helps to achieve new insight into nature. That is why with Shape we make images ... and more ...

How does it work?

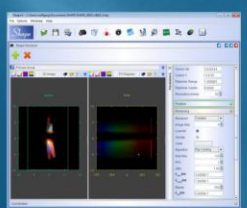
Shape provides visual interactive model building with highly customizable geometry and physics. Model rendering that mimicks observations allows direct comparison with telescope data. We want it to be easy and fast to learn and handle, so we can quickly get results and play with them before an inspiration evaporates.

What is Shape?

Shape is a morpho-kinematic modeling tool for astrophysical nebulae. Its desgin purpose is the analysis of the 3D structure and kinematics of astrophysical objects in a way that can be compared directly with observations. It is particularly suited to model expanding nebulae like planetary nebulae and other structures with clear kinematical signatures such as accretion disks and other streaming flows that can be studied using the Doppler-effect. Starting from a 3D structure with a model velocity field, Shape generates 2D images, position-velocity (PV-) diagrams, channel maps, lightecho maps and one-dimensional spectral line profiles for comparison with actual observations (Steffen, et al., 2010).

Modules

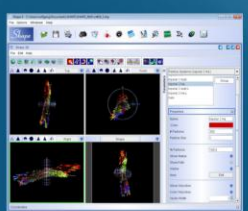
The software is divided into a number of modules. Each module incorporates fundamentally different tasks. Currently, the modules include 3D modeling, 2D image rendering, physics, math, 1D graph drawing, channel map display, animation, automatic reconstruction, optimizer, movie and notes. The 3D modeling and 2D rendering modules are essential for any project, while the inclusion of other modules depends on the particular project.



The rendering interface: here it shows a broadband rendering of dust scattering in our quick CRL 618 model. The right is the spectrum (vertical is the position along the slit).

3D Module

Shape uses modern, interactive 3D modeling techniques to "construct" the object in three dimensions. Following the lead of several commercial 3D drawing programs such as 3D Studio Max, Shape uses simple mesh shapes and modifiers to manipulate those shapes. Within this modifier framework one can create as complex a shape as needed. Additionally, modifiers can affect velocity and properties like density, thereby creating complex velocity fields and density distributions.



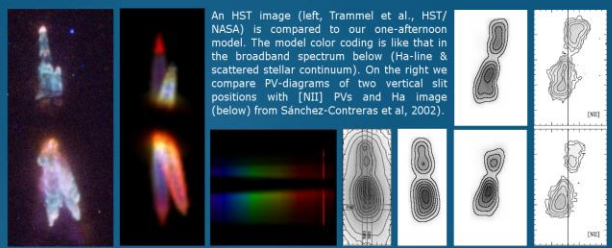
The 3D module with the mesh and velocity vectors of the CRL 618 model. Color coding of the vectors is according to the Doppler-shift.

The 2010 release

The main new feature in the 2010 version is a "transfer" renderer, which implements basic radiation transfer calculations, associated with a "physics" module to define complex physical emission and absorption properties of gas and dust. There is also a "math" module, which allows one to define physical quantities and relations between them. These can be used in other modules. There are also other new modules and a number of interface changes and a new online manual.

A one-afternoon model: CRL 618

As an example for effective modeling with Shape, we show the following demonstration project of CRL 618 that was created in a single afternoon. It includes the basic 3D geometry, physics setup of dust scattering and an emission line with a simplified bowshock-like velocity field at the tip of collimated ejections. Although this is not a fully developed model, it shows how quickly a rough model of a complex object can be created in Shape.



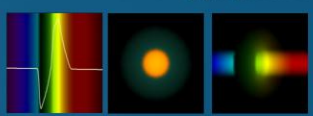
An HST image (left, Trammel et al., HST/ NASA) is compared to our one-afternoon model. The model color coding is like that in the broadband spectrum below (Ha-line & scattered stellar continuum). On the right we compare PV-diagrams of two vertical slit positions with [NII] PVs and Ha image (below) from Sánchez-Contreras et al, 2002).

Eclipsing binary lightcurve

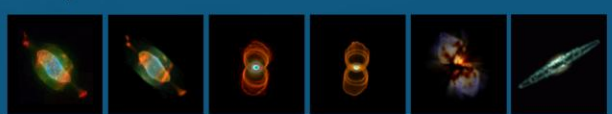
Another "single afternoon" example is this generic model of an eclipsing binary. A star filling its Roche-lobe is in orbit around a compact star with an accretion disk that has a spiral emission pattern. The rendered image, the wireframe model and the resulting lightcurve are shown (from left to right).

P-Cygni profiles

P-Cygni profiles provide information on stellar winds and expanding shells. Here is a stellar wind around a star with a continuum spectrum. The H alpha emission and absorption was calculated with the new Physics Module. Note the 2D profile (right), gives insight in how P-Cygni profiles works.



Gallery



HST image of NGC 7009 (left, Balick et al., HST/NASA) and a Shape model (right, Steffen et al., 2009).

HST image of the Hourglass (left, Sahai & Trauger, HST/NASA) and a Shape model (right, N. Koning).

Hypothetic models of a PPN with dust scattering (left) & an edge-on galaxy with extinction (W. Steffen).

References:
Sánchez-Contreras, S., Sahai, R., Gil de Paz, A., 202, ApJ, 578, 269
Steffen, W., Koning, N., Wenger, et al., 2010, "Shape: a 3D modeling tool for astrophysics", IEEE Transactions on Visualization and Computer Graphics, in press.

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"Get your ideas in Shape."

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