

PARALLEL PROCESSING

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Electronic Information

Viewing Optics Express Movies on Unix

BY BOB JOPSON

"This is so unbelievably cool . . . now I want to read the article so I can understand it," said an OSA member—after a half-hour of telephone coaching—when he first viewed a movie of the output beam patterns from a quasi-stadium-mode resonator on *Optics Express*.¹ In that instant he understood how online journals, with their color, movement, and sometimes sound, can provide a new and potentially better way of conveying technical information. For instance, Figure 3 of that same article contains four curves, two of which mostly overlap. Without color, the curves would be indistinguishable. The member's enthusiasm was enhanced, no doubt, by a rapidly approaching conference deadline, but, even lacking a dire desire for diversion, you, too, will be pleasantly surprised the first time you view a multi-media *Optics Express* article.

For anyone using a PC, being able to view *Optics Express* is relatively straightforward: Go to www.osa.org, click on *Optics Express*, then click on the cover figure or the *Optics Express* title. Once there, click "Help," then "*Optics Express* Toolbox," and follow the instructions for loading Acrobat Reader and Quicktime. After the usual missteps, backsteps, and repeats, you will be reading *Optics Express* and your world will become wider.

For Unix users, *Optics Express* viewing may not be so easily accessible. Acrobat Reader is often present on Unix systems, but a Unix version of Apple's Quicktime viewer does not exist. One movie viewer that will work (on an X-Window interface) is XAnim, a public domain program that you can download, unpack, compile, and run. The remainder of this column discusses how to accomplish this task.

According to the documentation, XAnim supports a variety of formats including Quicktime, AVI, DL, and GIF89a on many systems, such as Linux, Sun OS, Solaris, BSD, and HP, NEC, and DEC products. I loaded XAnim using Netscape 4.04 on a Sun Sparcstation 2 running Solaris and used it to view the Quicktime movies in *Optics Express*. Given the variety of Unix systems and tools, your procedure will be similar, but not identical, to mine.

First go to the XAnim homepage (<http://xanim.va.pubnix.com/>) and click on "gzipped tar archive of XAnim 2.70.6.4." After you select a directory, a compressed tar file (`xanim27064.tar.gz`) is downloaded. Uncompress it using "gunzip -v xanim27064.tar.gz" to create `xanim27064.tar`. (If you do not have "gunzip" on your system, you can use the command "uncompress" instead. In that case, you must download a different file by clicking on "a unix compressed tar archive of XAnim 2.70.6.4." Now unpack it with "tar -vxf xanim27064.tar" to create a subdirectory, `xanim27064`, and fill it with a myriad of files. One of these files will be `Compile.Help.doc`, which contains detailed information about the next steps.)

If your Unix system has an imake system configured, try that first to

simplify loading. Edit the "imakefile" file, following the instructions contained in it—usually you do not have to make any changes—then enter `xmkmf`. This will combine various system imake parameters with those found in the `imakefile` to create a `makefile`. Now enter `make xanim`. This will compile and link the various components of the XAnim package according to the instructions contained in the file "makefile." If all goes well, XAnim is ready to use. If all does not go well, you may be able to deduce the error from error messages and fix it by editing the "makefile" file.

Alternatively, you can bypass the imake utility and create `makefile` yourself. Start by copying the file "makefile.unx" into `makefile` and then edit `makefile` according to instructions contained within. Next enter `make xanim`. A list of common problems is in the file "Compile_Errs.doc." It is also possible that XAnim will work even though error messages are generated while "making" it.

The next step is to configure your Web browser to run Acrobat Reader and XAnim automatically. For example, to configure Netscape 4.04, click "Edit," then "Preferences," followed by the triangle next to "Navigator" and "Applications." Use "New" or "Edit," as appropriate, to ensure that the list of helper applications includes one with a description similar to "Portable Document Format," of MIMEType "application/pdf," with a suffix of "pdf." It should be "Handled By," "acroread %s," or whatever you call your Acrobat Reader. Similarly, you want another helper to be described as "Quicktime Video" of MIMEType "video/quicktime," suffixes "qt,mov" and Application "\$PATH/xanim" where \$PATH is the

director path to XAnim. Some browsers require modification of a mailcap file. A helpful page containing a link to this information as well as other XAnim information can be found at <http://graffiti.u-bordeaux.fr/MAPBX/roussel/fra/xanim.html>.

Once everything is working you are ready to view movies on *Optics Express*, and echo, "This is so unbelievably cool."

Reference

1. Figures 4a and 4b in T. Fukushima *et al.*, "Beam propagation behavior in a quasi-stadium laser diode," *Optics Express* **3**, 21–28 (1998).

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Engineering

Self-focusing in Nonlinear Optical Media

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Self-focusing and self-trapping in nonlinear optical media were discovered soon after the invention of the laser in the early 1960s.^{1–5} These phenomena explain the appearance of hot spots and associated optical damage in media irradiated by high power laser pulses. The high intensities achievable with the laser made it possible to observe these and other nonlinear effects that depend upon the change of the refractive index of the medium in

response to the local electric field intensity.

The physics of optical nonlinearity

In a medium exhibiting third-order nonlinearity, the index of refraction n depends on the local E -field intensity $I(x, y, z)$ as follows:²

$$n(x, y, z) = n_0 + n_2 I(x, y, z)$$

Here n_0 is the medium's background index of refraction (observed at low optical intensities), and n_2 is the nonlinear coefficient of the material. Whereas n_0 is a dimensionless quantity, the nonlinear coefficient n_2 has units of area/power. Several physical mechanisms can cause the refractive index of a given medium to depend on the E -field intensity; notable among them are anharmonic motion of electrons in crystals, electrostriction, and the molecular orientation known as the Kerr effect.² Electrostriction is caused by the volume force of an inhomogeneous electric field within a dielectric medium. The volume force draws the material into the high-field region, increasing its local density and, consequently, its refractive index. Optical glasses, such as fused silica, exhibit both electronic and electrostrictive nonlinearities, their n_2 values being in the range of 5×10^{-16} to 5×10^{-15} cm²/W. The Kerr effect is observed in materials whose molecules possess anisotropic polarizability and tend to be aligned by the E -field, thus causing a change of the local refractive index. The liquid carbon disulfide (CS₂), which has a fairly large $n_2 = 2.6 \times 10^{-14}$ cm²/W, is a good example of this class of materials.

When n_2 is positive, the index of refraction in regions of high intensity tends to be larger than that in regions

where the E -field is weak. Consequently, for an initially collimated and localized beam profile (such as a Gaussian), the wavefront propagating through the medium develops a phase pattern that resembles the curvature of a converging beam. While diffraction effects tend to broaden the cross-section of the beam, wavefront curvature—caused by nonlinearity—attempts to pull the beam toward regions of higher intensity. As long as the nonlinear effect is weak, diffraction predominates; however, as one increases the beam's power, a point is reached where the tendency of the beam to become focused balances the effects of diffraction. The beam can then propagate over long distances without any noticeable expansion or contraction. Physically, the field has built an effective waveguide for itself, which enables it to propagate without spreading. This phenomenon, known as self-trapping, occurs at the critical input power $P_{cr} = 0.146\lambda^2/(n_0 n_2)$. Typical values of P_{cr} are 33 kW for CS₂ at $\lambda = 1 \mu\text{m}$, and 0.2–2 MW for common optical glasses in the visible and near-infrared range. Self-trapping is inherently unstable and readily destroyed by slight perturbations of the wavefront; nonetheless, it is possible to arrange well-controlled experiments to demonstrate the phenomenon.

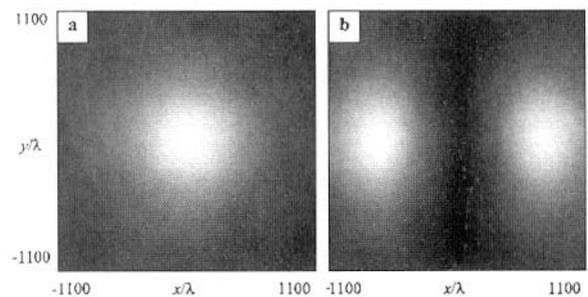


Figure 1. Plots of intensity distribution for (a) the X-component and (b) the Z component of polarization. These plots represent the cross-section of a Gaussian beam having a $1/e^2$ radius of 1000λ .