Introduction to the movies

After some general comments, we give a brief description of each of the movies created for “Wavepacket propagation into a negative index medium” by Xiaobiao Huang and W. L. Schaich, submitted to American Journal of Physics.

The movies are in Shockwave Flash format (.swf). A player is bundled into most modern internet browsers, such as Netscape or Explorer. Alternatively, you may visit
`http://www.macromedia.com/shockwave/download/alternates`
to determine a suitable player to download. One needs only to open a particular .swf file from within the browser or player to view the movie. Each will play repetitively until one hits the “back” button.

The first two movies are for one-dimensional (1D) motion, while the remainder are for two-dimensional (2D) motion. For each we specify the magnitude of the (central) incident wavevector, k_0, relative to the plasmon wavevector, $k_p = \omega_p/c$. For the 2D movies we also give the angle of incidence with respect to the surface normal, θ_i. For the 1D movies, $\theta_i = 0$. Each movie shows the space-time evolution of the (dimensionless) electric field. The polarization of this field is by choice always perpendicular to the plane of incidence. The field of view extends over $-100 \leq k_p x \leq 100$ for the 1D movies and over $-140 \leq k_p x, k_p y \leq 140$ for the 2D movies. Here $x = 0$ is the plane between vacuum (in $x < 0$) and medium (in $x > 0$). It is marked with a vertical line. For the 1D movies the ordinate is the electric field. For the 2D movies the space variable y runs in the vertical direction and the horizontal line (the surface normal) marks $y = 0$.

For each movie we specify the index of the medium being entered (at $k_0 = \omega_0/c$), the gaussian width parameters (a in 1D, a_1 and a_2 in 2D) of the incident packet, and the time range. This range is written as, say, $\omega_p t = -100(1)100$ which means that $\omega_p t$ ranges from -100 to $+100$ in steps of 1 (i.e. 201 frames). We also note how many frames per second (fps) are used in the movie. For the 2D movies the electric field strength is indicated by a color scale that ranges from dark blue to dark red. A white disk is used to show where the classical center of the wavepacket lies at any moment. These disks move along straight lines at the appropriate group velocity and touch $x = 0 = y$ at $t = 0$.

Now we list specific descriptions.

Mov.1 1D wavepacket with $k_0/k_p = \sqrt{0.5}$, $k_pa = 20$, and ω_pt in the range $-160(1)200$, moving from vacuum into a NIM with $n_0 = -1$ and 12 fps. Compare with Figs. 4–6 of text.

Mov.2 Same as Mov.1 except a nonzero damping is included, described by $\omega_p\tau = 100$. Compare with Fig. 6.

Mov.3 2D wavepacket with $k_0/k_p = 0.5$, $k_pa_1 = 20$, $a_2 = \sqrt{2}a_1$, $\theta_i = 45°$, and ω_pt in the range $-218(1)280$, moving from vacuum into glass with $n = 1.5$ and 12 fps. Compare with Figs. 7–9.

Mov.4 Same as Mov.3 except that the medium in $x > 0$ is a NIM with $n_0 = -3$ and the time range is extended to $-218(1)568$. Compare with Figs. 7, 10–12.

Mov.5 2D wavepacket with $k_0/k_p = \sqrt{0.5}$, $k_pa_1 = 30$, $a_2 = \sqrt{2}a_1$, $\theta_i = 20°$, and ω_pt in the range $-200(1)375$, moving from vacuum into a NIM with $n_0 = -1$ and 12 fps. Compare with Figs. 14,15.

Mov.6 Same as Mov.5 except $k_0/k_p = 0.8$ and $\theta_i = 10°$. The index at the (central) incident frequency is $n_0 = -9/16$. Compare with Figs. 16,17.

Mov.7 2D wavepackets with $k_0/k_p = 0.5$, $k_pa_1 = 20$, $a_2 = \sqrt{2}a_1$, and ω_pt in the range $-100(20)600$, moving from vacuum into a NIM with $n_0 = -3$ and 2 fps. There are separate clips for the incident angle $\theta_i = 30°, 45°, 60°, 75°$. The jumps in ω_pt are too large to properly show the backwards motion of the phase bands in the NIM, but one can see the extra distortions of the reflected and refracted envelopes that become greater as θ_i increases.

Mov.8 Same as Mov.7 except $k_0/k_p = \sqrt{0.5}$, $n_0 = -1$, and $\theta_i = 30°, 45°, 60°$. The extra distortions are more noticible. Compare with Mov.5.

Mov.9 Same as Mov.7 except $k_0/k_p = 0.8$, $n_0 = -\frac{9}{16}$, and $\theta_i = 15°, 30°, 45°, 60°$. The critical incident angle beyond which there is total reflection at ω_0 is 34.2°. Compare with Mov.6.