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**Bessel Beams**. Only in 1987 did a guy named Durnin notice that the simple function exp(zik-par) times $J_0$(rk-perp) satisfies the wave equation, where k is simply separated into perp and parallel components. This solution is called a Bessel Beam. The significance of this solution is that it has a transverse pattern that is independent of z, meaning that this beam does not diffract! The total energy stored in such a beam would have to be infinite since it goes infinitely far, but it sparked interested in making practical pseudo-Bessel beams for use in medical tools and whatever. One early attempt to simulate such a beam was to use an aperture consisting of a circular slit (delta function) at radius a, since this makes a beam with amplitude $J_0$ (kasin$\phi$), and then to run that through a converging lens to try and remove the sin$\phi$ dependence, sin$\phi$ = r/z. Notice that as you vary z, the ideal Bessel beam has a constant amplitude.

**app_Bessel_beams.pdf.** See comment about Bessel Beams above. This short technical monograph is very readable. The subject is "apertured Bessel beams". They are exploring what kind of radial function you might put in your aperture to get good control over the amplitude of the resulting beam on axis as you move away from the aperture. Good control means a steady amplitude. As we know, $J_0$ appears in the radially symmetric integral. The "hard hole" and various amplitude plate functions are considered. No dramatic conclusions. An axicon is a phase plate with phase exp(-i$\alpha\rho$), and it does a pretty good job, especially when hit with a Gaussian beam. They try a negative axicon together with a Gaussian amplitude aperture and get their best result. This is just an example of the kind of paper I can now easily read.

**April 9th - Diffraction & the Fourier Transform.pdf**. This is a set of slides for a course using a text by Hecht. The slides form a lecture on diffraction. It starts without proof with the Huygens convolution formula with exp(ikr/r) inside and no obliquity factor. It then goes to the Fresnel approximation. Plots a slit diffraction field at various distances. Shows edge diffraction and has a picture of Cornu, but not details about how to use it. Mentions spot of Arago, and Babinet in the simple off-axis form, with example of diffraction from holes versus dots in an array. Next goes to the Fraunhofer and notes it is the Fourier Transform in 2D. We then do slit, square hole, and round hole in the F limit. Next we do the Rayleigh resolution criteria which is dx = 1.22 f$\lambda$/D for a lens of f, diameter D. Finally it does multiple slits showing combination of interference and diffraction. Goodman's FT of "3" is shown.

**BYUOptics10.pdf.** These are formal notes. We start with Huygen's integral with no obliquity. The two-term Kirchhoff integral is then derived with Green's Theorem. It is then assumed that exp(ikz) displays the only z-dependence of the E field, which allows dE/dn to be computed in one term, and then we end up with the Kirchhoff (1 + cos)/2 obliquity factor. Babinet is the next subject, but just arm waving only. In the next section, we set obliquity to 1 and do the Fresnel approximation, and then the Fraunhofer limit of that result is written out. Then (10.6.7) shows the Fresnel formula assuming a radially symmetric source, and then the Fraunhofer limit of that is taken. Finally, the last two sections talk about the scalar versus the vector wave equation, and why exp(ikr)/r is not really a solution of the vector equation. The very last section reviews Green's theorem. Not a bad set of notes.

**ch7_part1.pdf.** This interesting paper is on the subject of **slot antennas** for radio use, and is based on the basic Babinet idea that a vertical slot is the same as a vertical diplole, except E and H are swapped. One result is that a vertical slot causes horizontal electric polarization. I have not read the paper.

**diffsum.pdf**. This is a collection of power point slides combined 6 to a page, you can zoom in on them. The level is fairly **elementary**, but full results are quoted, such as for Airy. Airy with white light is shown, the red goes on the outside. Airy from **moonlight** on thin clouds is mentioned. Use Airy width to estimate size of particles in an **emulsion**. Microscope, **numeric aperture**, holograms, Airy from random group of disks. This is the kind of stuff you teach if you are assigned to a health services class!

**eikonal.pdf.** This is a lecture from our friend **Victor Jones** at Harvard, but not so labeled. The **eikonal equation** is derived and then applied to **mirages** as its "first application", lots of math rigor here. The eikonal equation shows how a ray vector direction changes along a path in a slowly varying medium. The "second application" is to first quote the **matrix optics** method, and then to show what the matrix is for a constant medium, since angle does not change, the **translation matrix**. As a third application, he applies the eikonal equation to make the so-called **saltus condition** from which we get **Snell's law**, and then he gets the matrix for that. He assumes you already know about this matrix stuff, so I had to digress while reading at this point. He then does the matrix for a **thin lens**, and then for a **GRIN lens**. A GRIN rod has a power-law radial function for index, but he specializes soon to m=2, quadratic. He uses the eikonal again to get the matrix for the GRIN lens. The ray pattern looks like a sine wave, and if your length is half wave, then you can use such a chunk of rod as a focusing lens, some pictures are shown. As his final offering, Jones rederives the eikonal equation using **Fermat's Principle** of the path minimizes the phase or time. He uses that little Euler equation I recently reviewed, and the result drops out. In doing this, he introduces the idea of a **Lagrangian** whose integral is being minimized. As one final burst, he goes on to define a **Hamiltonian** from that Lagrangian in a standard manner and comes up with a ray optics Hamiltonian that looks like that for a relativistic particle. Well, no great surprise perhaps. He treats this only as a curiosity. All in all, a very nice set of notes!

**FresnelDiffraction.pdf.** This is Wyant's paper I printed and made separate notes on. It does the Fresnel Zones, and Zone plates, and computer plots for various apertures.

**gaussianbeamslecture24.pdf.** This is a set of low-density lecture slides. It quotes the paraxial transverse wave equation and then quotes the Gaussian beam form as solving in, no proof. Notes that there is also a Hermite solution. Comments on the ABCD business, no proof. Just a summary of facts really.

**gaussianbeams_eoe.pdf.** This is a very detailed Gaussian Beam article written for the Encyclopedia of Optical Engineering (EOE). The Fresnel length L is referred to her as the Rayleigh range, the distance you go to get to make sqrt(2) increase in waist. The funny extra tangent phase is called the Guoy phase shift, it jumps by pi at the waist. He goes on to talk about variations of the basic Gaussian beam, and then he derives the A.B.C.D tranformation law, which I did appreciate. He generalizes this law to weird beams. This Spanish author has done a pretty thorough job.

**Lecture 04-GaussTransf.pdf.** This is another Gaussian beam slide show. It quotes some updated book of Yariv which must have added a chapter on this subject (my copy has very little). Nothing really new for me in this document. Mentions some of the optics matrices, the Hermites, lens affecting Gaussian beam, and so on, just a summary slide set.

**matrixOptics.pdf**. (geometric optics) This is *not* the set of printed notes I learned this subject from, but it does talk about the cardinal points. It states that you use the positive principle points to do ray tracing, such that you can ignore what the ray actually does inside some thick lens assembly, so that is WHY these

points are useful, something my paper neglected to say. References to books by Yariv and Hecht perhaps for matrices. This paper tells you how to ray-trace with fat lenses using the cardinal points, also has a table of matrices, but nothing I have not already seen in this table.

**Books**: These notes are on "Hecht Chatper 6". This book is 4th Ed in August 2001 at $106 and would probably be one I should buy, 700 pages. Born & Wolf is in 7th edition, still going, October 1999, at 900 pages. This is a deal at a mere $65, amazon shows the contents. So this is one way I can use the web to deduce what books to get.

**Maxwell.doc.** We go in detail from Maxell's Equations to the **vector wave equation**. Then comes the **eikonal equation** and one of its forms called the **ray equation**. Then a quick statement of Fermat. So think of this as really being notes on the eikonal business.

**microscopy.pdf**. This is a very long and good-looking paper about optical microscopes and all their little details. I have not read it.

**vitreous_humor_flow.pdf.** The authors note an interest in administering eye drugs by injecting them into the vitreous of the eyeball, so they want to know how things **diffuse** in the vitreous. They studied cow eyes. Results are poorly stated, but there are references to other papers. This is a 2 page paper.

**WaveOptics.pdf**. A nice set of slides that I have used many times. Lots of **pictures**. Has basic stuff on the Gaussian beams that I like. Shows a Bessel beam too, see above notes. Talks Airy, edge, then Fresnel Lens. This has the original Babinet pictures of hole and disk that were once confusing me.

**WyantOptics505ClassNotes (folder)**. I downloaded lots of notes here, the Fresnel one summarized above is really the only one I have read. I liked the guy so brought in all his stuff for possible future reference.