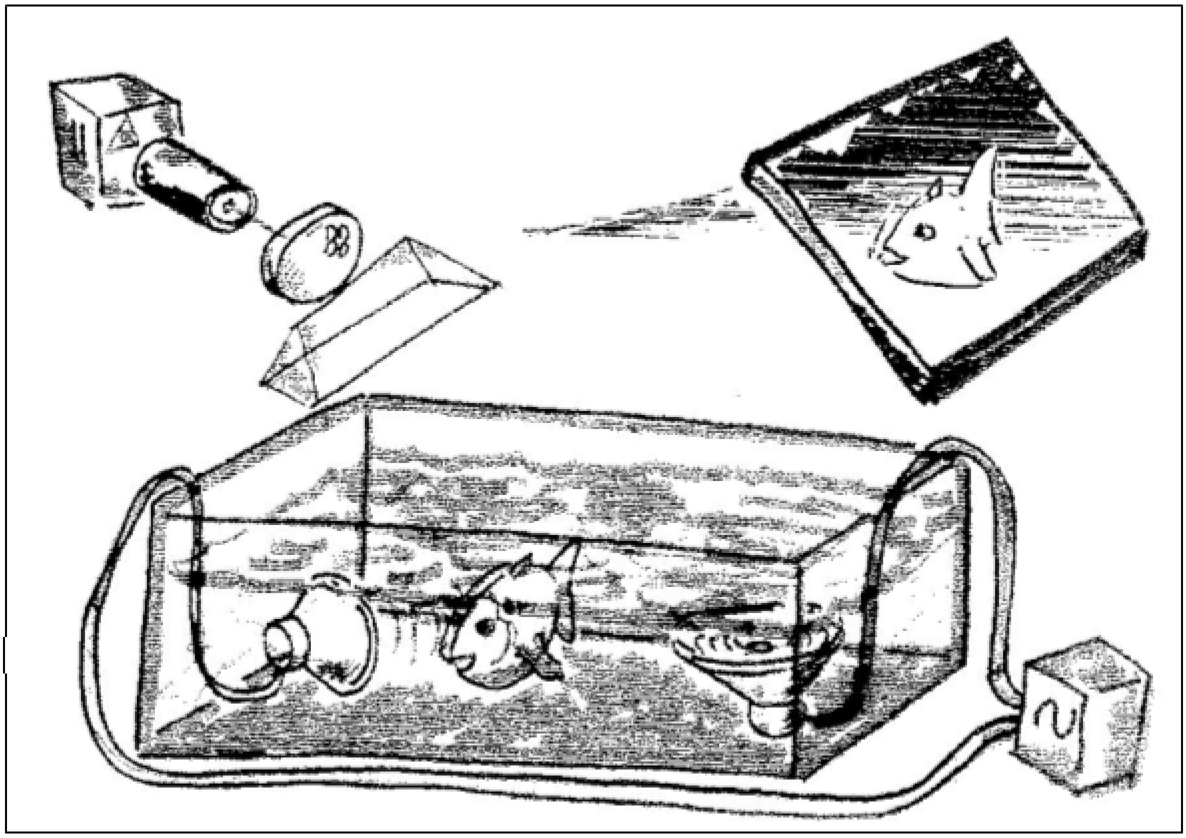
Quantum Holography - Illustration of the Concepts

Figure 1 below is an illustration of a acoustic/electromagnetic ‘holographic’ transducer.
It shows the holochoric transduction of the 3 dimensional holophonic image of a fish from water (in a tank) to the 3D holographic one in the air (above the tank) by means of an water/air surface wave interference pattern /hologram (courtesy of Dr. Uwe Kaempf).

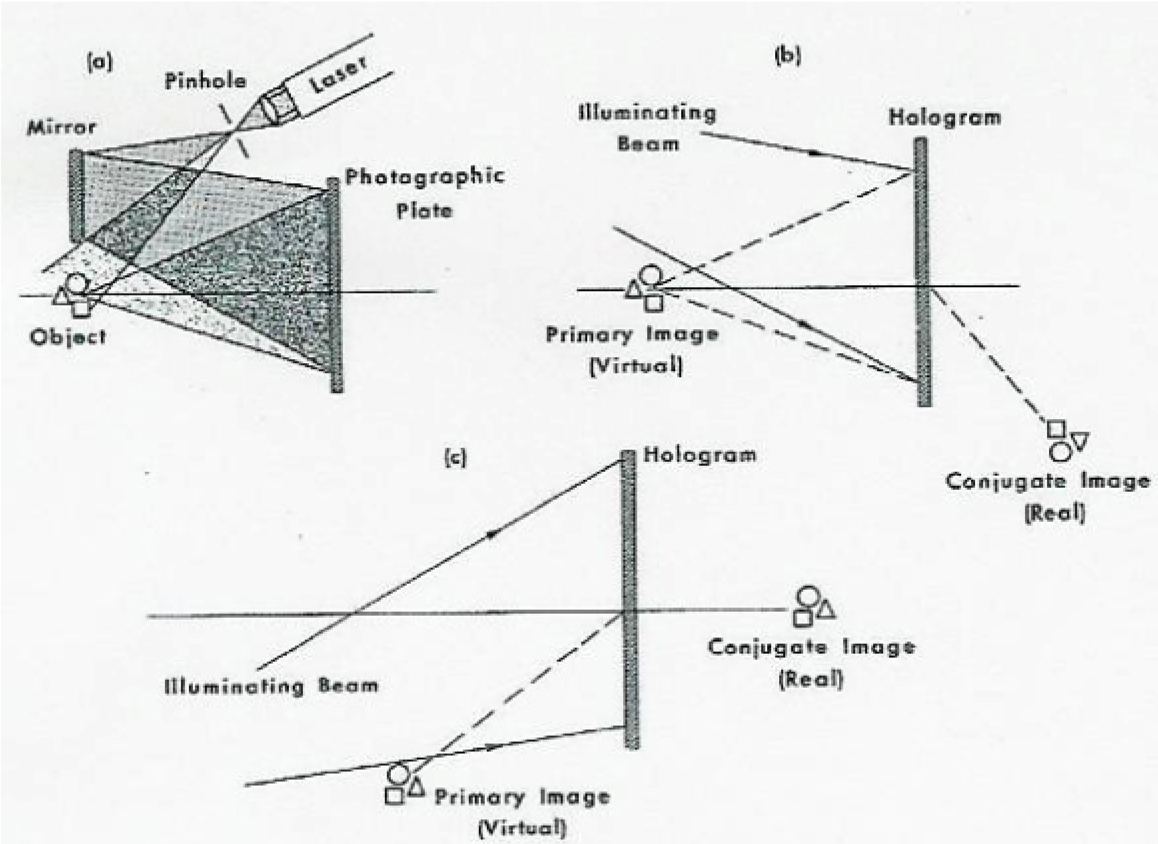


Such a transduction of a 3D object image illustrates the fact that when any 3D real object is illuminated by any kind of physical wave (holochory) including as shown later quantum mechanical ones, that real changes take place quite naturally in local amplitudes and phases of the incident illumination so as to encode/capture the 3D image of the object. Such an experiment using the processes of holography, the principles of which are described in more detail below in Figure 2, demonstrates that full wave front reconstruction/ decoding of the object image can be carried out through the intermediary of a wave interference pattern or hologram, that acts as a record of that object image.

Figure 2 - Holochoric Encoding and Decoding – the experimental principles

The well known recording of a hologram and the subsequent wavefront reconstruction of an object image is shown. In (a) a laser beam is first expanded by a pinhole and then divided by a mirror, which beams part of the illumination directly onto say a photographic plate, while the rest of it is reflected from the object. This plate, after processing then allows the hologram formed to be replaced in its original position, figure(b), after the object has been removed. Still retaining the illuminating beam, the light diffracted from the hologram then forms, in part, the same wavefront that was originally scattered by the object. This object as the source of the object image is thus replaced in accordance with Huygens’ principle, by this wavefront - its system of secondary sources. It allows the viewer looking through the hologram an undistorted view of the object, just as if the object were present. In addition to this virtual or primary object image, a real or conjugate image is also formed on the viewer's side of the hologram. This image will appear unsharp and highly distorted and it will be reversed back to front as shown in (b). However a distortion-free real image can be formed by changing the position of the illuminating beam, known as the reference beam, so that all its rays are reversed in direction, and a real three dimensional image of the object appears in front of the hologram as in (c).

Figure 2.



It is noted that not to use the whole of information encoded by both amplitude and phase arriving at any biological sensory apparatus in the incident illumination, for holochoric full wave front reconstruction of the encoded 3D object imagery (which the above description make clear presents no obstacle in principle) would constitute an evolutionary disadvantage to its organism. For not only would full wavefront reconstruction yield an immediate 3D holochoric perspective of the whole of the object imagery arriving at the sensory apparatii, it would also allow this new imagery in the form of a hologram to be compared with such previously stored imagery, and allow it to be acted upon in accordance with the importance of that previous imagery as recognized from past experience. That is, we suppose that each sensory apparatus is a holochoric transducer (or array of such) and that successive 3D object imagery in the form of holograms is input to an holochoric encoding/decoding filter bank and memory (initially empty) of the organism's holochoric experience.

Furthermore, as is now supported by extensive published research cited elsewhere in these homepages http://www.bcs.org.uk/cybergroup.htm, the conditions which make quantum holography possible, are ideally suited the hypothesis that the brain works in this way by quantum holography, functioning as a thermodynamic Quantum Carnot Engine (QCE) rather than as is always assumed a classical Carnot Engine (CCE) where thermodynamic disorder would indeed be a paramount obstacle to its quantum mechanical functioning. Indeed the loss of consciousness the brain suffers if its temperature moves outside its specific working range, would indicate that the quantum coherence necessary for its functioning as a QCE had been reduced or lost, so that it can no longer function as a QCE and is limited to its autonomic functioning as a CCE. Indeed this may also happen, when it switches itself into a state of non-dream sleep so as to conserve energy and rest. Dream sleep can then be hypothesized to concern the brain's re-optimization of its own quantum coherence, preparatory to its next period of full consciousness and conscious thought.

The condition necessary for quantum holography to take place is phase conjugation, Figure 3 below. It leads to detectable (phase conjugate) adaptive resonance, as for example, happens in (nuclear) Magnetic Resonance Imaging systems (MRI) in worldwide use for medical diagnosis, an example of which is shown in Figure 4.

Figure 3

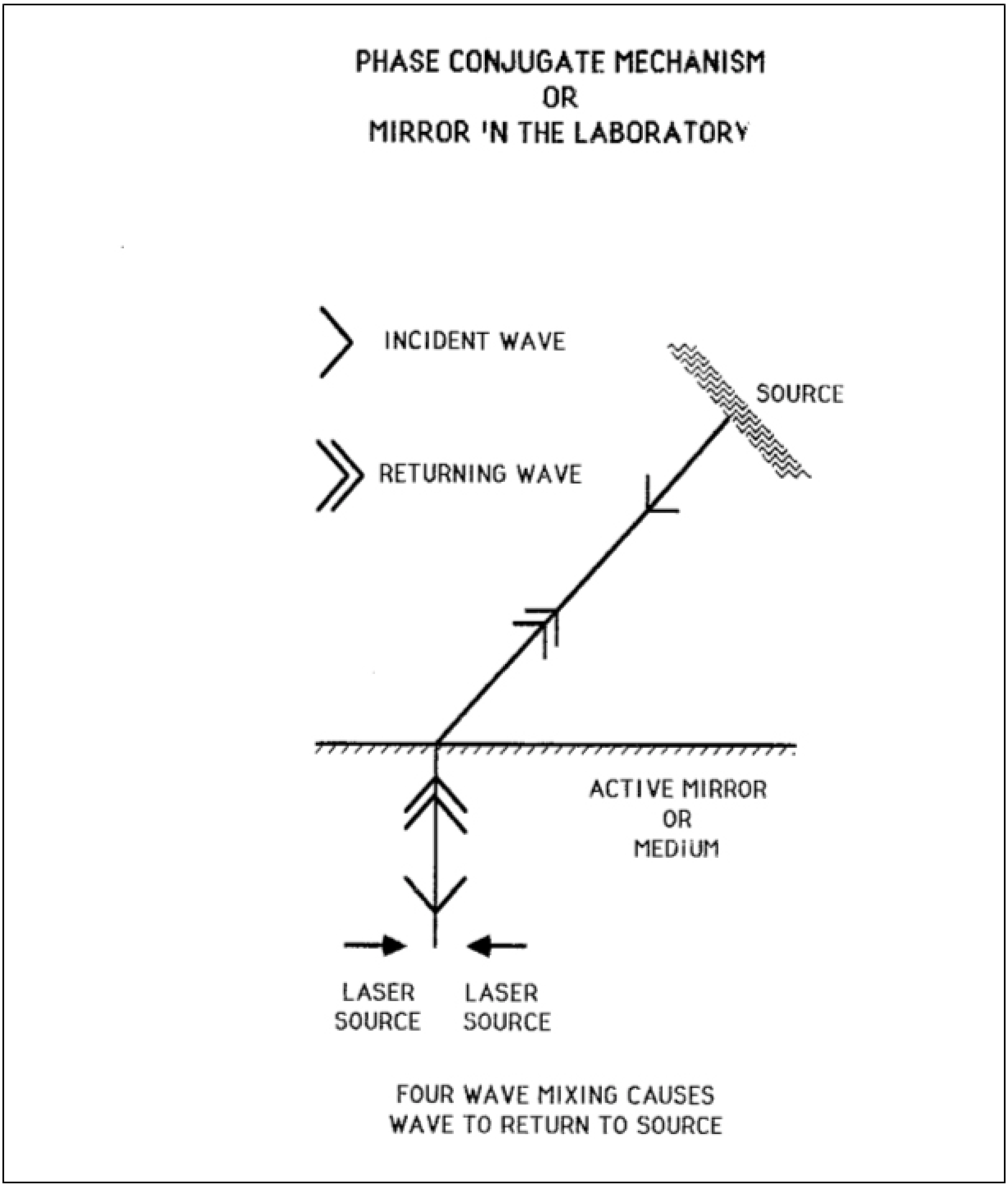


Figure 4 A Quantum Hologram - photos courtesy of Professor Walter Schempp.

Figure 4 (later) shows a wave diffraction pattern A from such an MRI machine, and in this case, the 2D slice image B of the human brain that is produced from A as the result of symplectic fast Fourier transform action. The three views correspond to :- the whole pattern (top); the whole with its center removed (middle); and with only is its centre remaining (bottom). They demonstrate its holographic nature, as each A results in a 2D image of the whole brain slice, but with reduced resolution in the lower two.

Brain function and Memory organization.

It is therefore worthy of note that all our own brain's sensory object imagery is perceived to be phase conjugate! That is to say, we sense such imagery to be outside the head coincident with the 3D objects themselves! Just snap your fingers and ask yourself where you hear the snap! Or reach out and touch an object, and note that both the visual and tactile sensations of the object which you experience are outside your head coincident with the object's three dimensional surface. And indeed if they were not so, it is clear that no biological sensory organism could survive for long if at all.

Furthermore phase conjugation defines 3D imaging, sometimes called super resolution imaging, where the sharp frequency adaptive coupling conditions (appropriate to the above mooted holographic filter bank and associative memory organization) specify very narrow spectral windows or ' pages' with no cross talk between them°°, such that the encoding and storage of the input holograms takes place by means of a de-multiplexing reference beam 'write' and its output/decoding of holograms to produce the required 3D virtual phase conjugate imagery corresponds to a multiplexing reference beam 'read'. This memory organization or 'minds eye and/or ear, etc' is therefore optimum it can be shown and cannot be bettered.

°° the pages satisfy the orthogonality condition of the Frobenius-Schur-Godement identity.

The question of Heisenberg Uncertainty.

But surely it will be argued the Heisenberg uncertainty appertaining to quantum holography should again prevent this happening. But remarkably the very reverse is true, because quantum holography is governed by the nilpotent 3D Heisenberg Lie group G, where Heisenberg uncertainty is defined in terms of this Lie group's nilpotent Lie algebra and where, because G is a Lie group, G possesses a dual or set of inverse exponential differentiable mappings. In this case therefore Heisenberg uncertainty is not an obstacle to computation of the 3D object imagery, but the actual means, by which it is can in principle always be rapidly effected, in a controlled way. This may even be the case in the presence of limited thermodynamic noise/disorder, for under the condition of phase conjugation for superresolution imaging of sound waves, for example, it can shown that the introduction of disorder within a phase conjugate/super-resolution sound wave system (in the form of a set of random rods) actually improves the focus of the waves! And this property is used to break up gall stones internally without damaging the surrounding tissue.

The above claim that in MRI, for example, the collapse of the wave function required for the calculation of the phase conjugate imagery, is followed by its inverse a re-expansion is illustrated in Figure 5, which shows the basis of how it is possible by means of suitable MRI quantum controls sequences, to extract a wave diffraction pattern from the machines, so as to permit their symplectic Fourier tranform conversion to the desired 2D or 3D object imagery of the object under examination, see site http://www.civm.duke.edu for 3D examples of MRI microscopy.

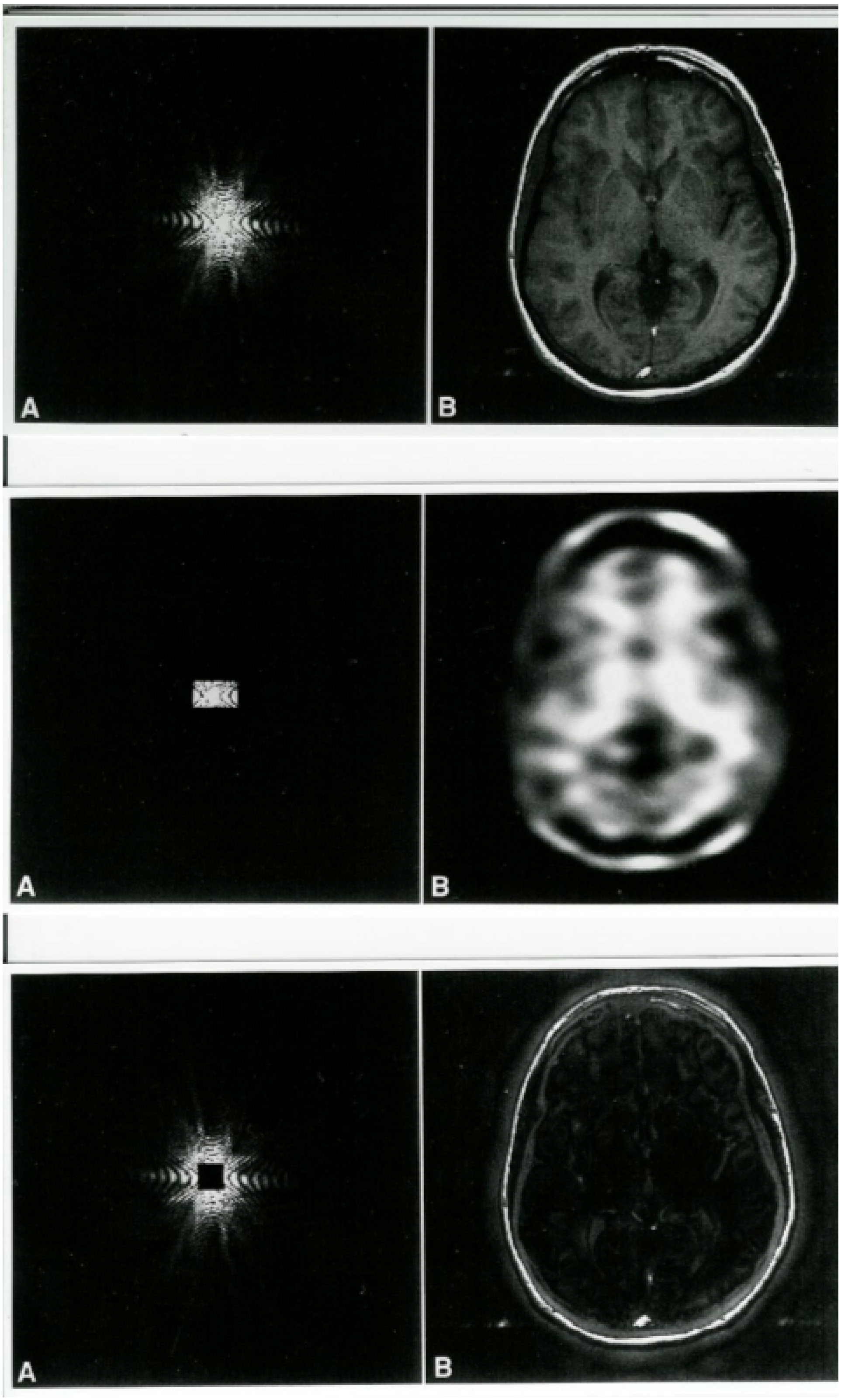


Figure 4 is an actual quantum hologram/wave diffraction pattern A and its brain image B as produced in Magnetic Resonance Imaging machines used in medical diagnosis. In A(middle, and bottom) the outside and inside of the pattern A(top) has been removed to show the reduced resolution of B, compared to B(top) to illustrate A's holographic nature.

Figure 5 Holochoric compression and decompression, courtesy of Professor Walter Schempp.

MRI Recovery trajectory of Free Induction (thermodynamic) Decay (FID) which is the basis of the image extraction process, showing the Heisenberg group G helix off resonance losing amplitude due to the transverse relaxation effect but gaining energy due to the longitudinal relaxation effect.

In clinical MRI, the Pfaffian of G allows the selection of the tomographic slice by an application of linear magnetic field gradients, such that the pitch of the Heisenberg helices is inversely proportional to the polarity of the linear slice gradients.

Illustrated in figure 5 is the Heisenberg helix after excitation by a $\pi/2$MRI magnetic pulse. The pitch of the helix indicates the energy gain due to the longitudinal relaxation effect. This is typical of a single-frequency FID.

This shows that MRI machines are indeed macroscopic quantum mechanical thermodynamic engines /QCEs, where the 2D and 3D images output as wave diffraction patterns as in Figure 4 are the result of well controlled quantum measurement, which can therefore be processed using standard digital computation to produce and display its images. The entropy production in the FID is therefore in this case both a measure of disorder and an information metric.

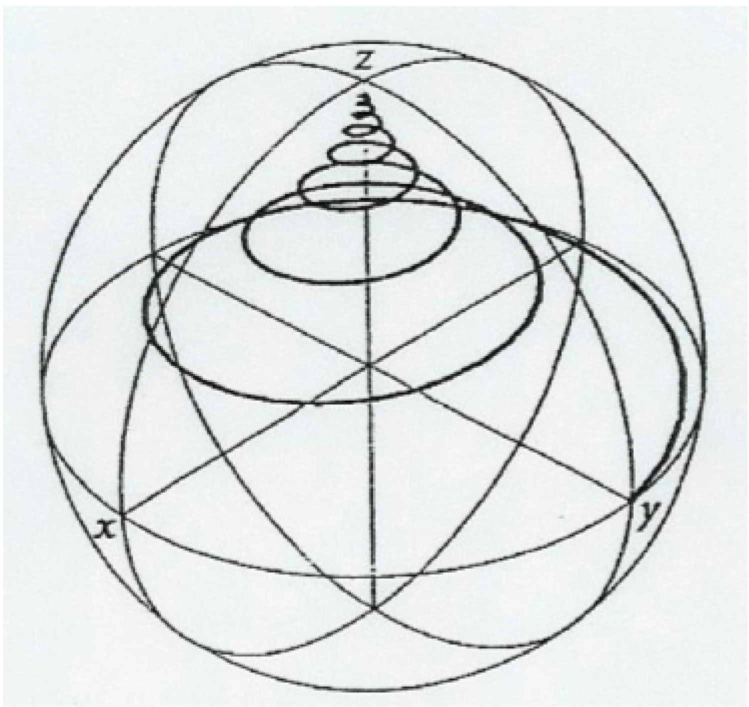


Figure 6 Hopf Fibration/Clifford Parallels

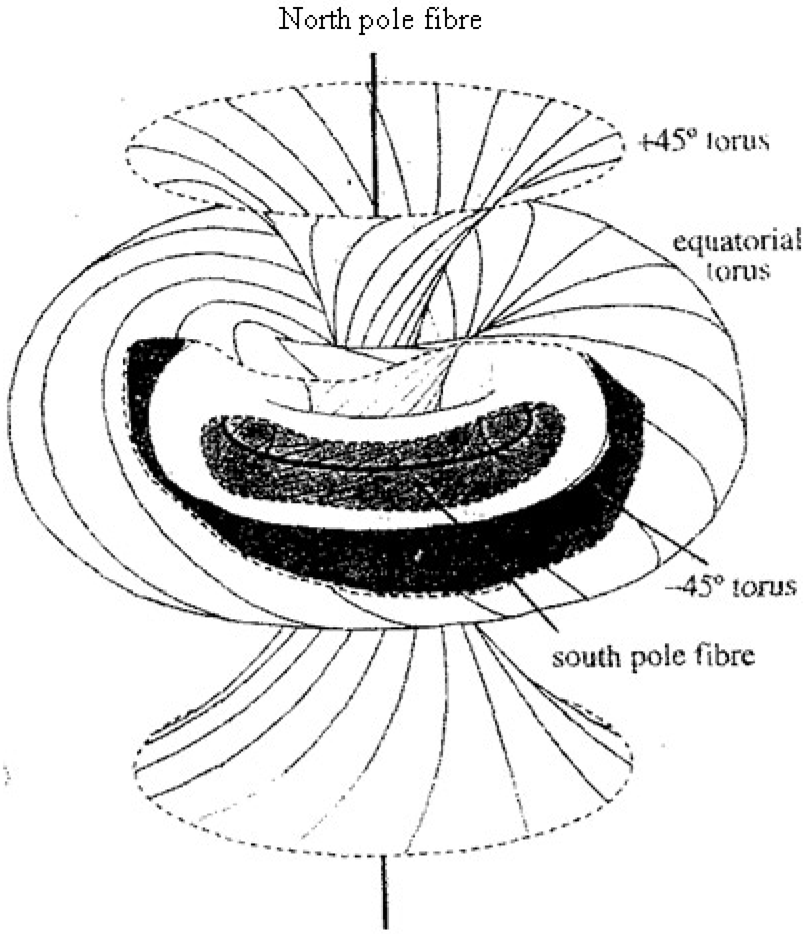


Figure 1: Cutaway perspective view in $\mathbf{R}^3$ of the Hopf fibration of S_3 over S_2: Visualization via stereographic projection of the foliation of S_3 —>$\mathbf{R}^4$ by nested flat tori. The Hopf fibration together with the bundle homomorphism S_3 —> S0(3, **R**) forms a fiber bundle model of the symplectic spin structure on the bitangent bundle of S_2, The traces of the bitangential planes on the flat tori are displayed as a bundle of Villarceau circles of parataxy. The Hopf bundle is tautologous in the sense that a point in P_1(C) represents a complex line in the Hermitian vector space C +C (tensor addition), and to this point its complex line is associated. By fiberwise multiplication with the time-line **R**, the four-dimensional Taub-NUT manifold arises which forms a cylinder bundle over S_2-

light echo phenomenon of extragalactic *quantum holography* **with radiation from the core of the galaxis serving as the reference radiation.**