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# SPACE MEDIUM THEORY OF LASER GYRO AND LASER SPEEDOMETER

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**Abstract**

*The basic equations for the laser gyro and a proposed laser speedometer are derived and the physical principles explained. The laser gyro and laser speedometer are "closed box" instruments for measuring angular velocity and linear velocity respectively. Two of the "invisible" reference frames from which these motions can be measured are identified in space medium theory. This opens new avenues for progress in science and presents a challenge to Einstein's special theory of relativity.*

## Introduction

The laser gyro is the most advanced navigational instrument for sensing angular velocity. The Sagnac experiment (Sagnac, 1913) is said to be a forerunner of the laser gyro. The instruments are similar in this respect: 1) Light is propagated around the instrument clockwise in one beam and counterclockwise in the other. 2) Light speed is c in the light propagating medium through which the instrument rotates. 3) Light speed within the instrument is slower than c going around in the same direction as the rotation and faster than c going around in the opposite direction. The anisotrophy of light speed in the reference frame moving with respect to the earth's surface is predictable from space medium theory (see Barnes, 1986).

This paper focuses on physical processes in the laser gyro that are not present in the Sagnac experiment, nor any of the other historical optical experiments for detecting angular velocity. What is most important is that the laser gyro yields *frequency difference*, whereas the Sagnac and other instruments yield only *phase shift*. The frequency difference is between *two resonant oscillator frequencies* in the resonant chamber of the laser gyro as it rotates with respect to the light-propagating space medium.

However, the first part of the laser gyro derivation involves the time difference for light to transit the rotating circuit in the two different directions. That portion of the derivation is the same as that in the Sagnac experiment. So the Sagnac equation will be derived and used as a first step in the derivation of the laser gyro equation.

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## Derivation of the Sagnac Equation

This Sagnac equation derivation is similar to one by Georg Joos (1964). Figure 1 is Sagnac's rotating instrument with its light source and four mirrors. Light transits the rectangular path in two beams, one clockwise and the other counterclockwise. Light is propagated in the space medium that does not rotate with the instrument. This derivation uses the light speeds with respect to the rotating instrument's frame of reference. The first step is to get the time of transit in each beam, then to get the equation for the time difference as a function of the angular velocity. From the instrument's frame of reference this involves light speeds less than and greater than light speed c.

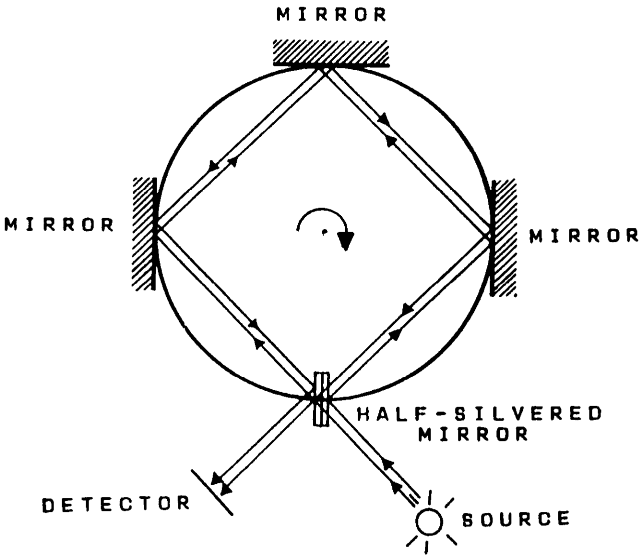


**Figure 1. The Sagnac experiment.**

Taking the axis of rotation as the origin, light travels along a curve whose polar equation is given by $r = r(\phi)$. If at any given instant an element of the curve makes an angle $\theta = \cos^{-1}(rd\phi/ds)$ with the direction of its *translational motion,* arising from the turning of the whole apparatus, then the relative speed when going around in the same direction as the rotation is

$$v_- = c - \omega r \cos\theta = c - r^2\omega\frac{d\phi}{ds} \tag{1}$$

and in the opposite direction

$$v_+ = c + r^2\omega\frac{d\phi}{ds}. \tag{2}$$

The difference in the two corresponding time intervals is

$$T_- - T_+ = \oint\frac{ds}{c - r^2\omega\frac{d\phi}{ds}} - \oint\frac{ds}{c + r^2\omega\frac{d\phi}{ds}}. \tag{3}$$

Since the second term in the denominator is small, this becomes

$$\Delta T = \oint\frac{2r^2\omega d\phi}{c^2} = \frac{2\omega}{c^2}\oint r^2 d\phi = \frac{4\omega S}{c^2} \tag{4}$$

where S is the area enclosed.

The phase shift in length is the time difference multiplied by speed c,

$$\Delta L = \frac{4\omega S}{c} \tag{5}$$

where $\omega$ is the angular velocity of rotation, S is the area enclosed by the light path. Sagnac measured displacement $\Delta Z$ of fringes in fractions of a wavelength, namely

$$\Delta Z = \frac{4\omega S}{c\lambda}. \tag{6}$$

## Derivation of the Laser Gyro Equation

The three-mirror triangular light path in the laser gyro is shown in Figure 2. One laser light beam transits the path clockwise and the other counterclockwise. A small portion of the light from each beam passes through the apex mirror and, by aid of the corner prism, both enter the readout detector as shown. When the instrument is in rotation the difference in frequency in those two beams is converted to angular velocity by the readout detector.

The derivation of the laser gyro equation is the same as that for the Sagnac equation up through Equation (4), the time difference equation. But from there the derivation must take into account the fact that the laser gyro is a *resonant optical system.* When in rotational motion it has two resonant frequencies. The difference in these two frequencies is proportional to the angular velocity. As noted by Joseph Killpatrick (1967); "The wavelength must be an exact integer fraction of the path around the cavity. This last condition determines the oscillation frequency of the laser." In that moving frame of reference the wavelength is constant and the speed of light is different from c.

Denoting the length of the circuit in the cavity frame of reference as L, and N as the number of wavelengths, the wavelength

$$\lambda = \frac{L}{N}.$$

In the space medium, there is a change in the path length and a change in the wavelength,

$$\Delta\lambda = \frac{\Delta L}{N}.$$

The frequency change is proportional to the ratio of changed length $\Delta L$ (extra length in the light propagating medium) to fixed circuit length L (inside the chamber),

$$\Delta f = \frac{(\Delta L)f}{L}. \tag{7}$$

Since $\Delta L = c\Delta t$, and in view of Equation (4), the frequency difference is

$$\Delta f = \frac{4\omega S f}{cL} \tag{8}$$

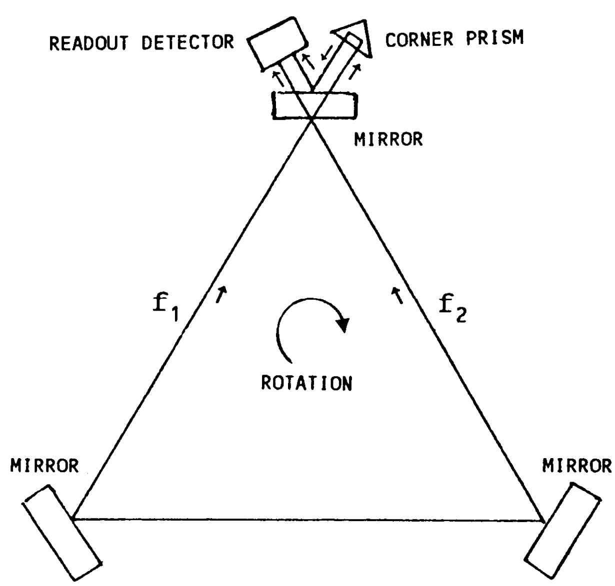


**Figure 2. Laser gyro beam paths.**

and when expressed in terms of wavelength is

$$\Delta f = \frac{4\omega S}{\lambda L}. \tag{9}$$

This is the basic equation for the laser gyro.

The frequency difference is measured in the readout detector. That is accomplished by the beam-combining optics and two photo cells in the detector. The digitized output and associated electronics provide angular velocity and angular orientation about the axis. There are three such laser gyro elements in the strapped unit in an aircraft, supplying rotational data from all three of its orthogonal axes of rotation.

Note that it was the space medium that enabled the author to derive the laser gyro equation in ordinary time and space, with no Einsteinian relativity involved.

### Constituents of the Space Medium

The space medium is different from the old absolute, single, all pervasive ether. It is a massless medium in space, but not fixed to space. The constituents of space medium are the independent vector electric and magnetic fields of all the electrons and protons in the universe. These are vector components in the medium. The net electric or magnetic vector may be zero, but these component vectors are there. *The components of a vector never vanish.*

At the earth the dominant constituency of the space medium is earth-entrained. The reason for this is that the electrons and protons in the earth are so much closer than the other electrons and protons in the universe.

In the Sagnac experiment the instrument was rotating with respect to the dominant constituents of the medium, that are fixed with respect to the earth. The other constituents of the medium, vector components from all the other electrons and protons in the universe, do not rotate with the earth. The earth rotates in that constituency of the medium. It is strong enough for a laser gyro at rest on the earth to sense the rotation of the earth. In fact that feature of the three laser gyro combination senses true north for the navigation instrument.

### Laser Speedometer

In a previous paper (Barnes, 1991) I proposed this laser speedometer to detect translational velocity through the space medium. In this analysis of the laser gyro, there was a clue that translation alters the resonant frequencies. However, at the output of the laser gyro it is not detectable because the increase (or decrease) in frequency is equal in both beams. There is no difference in frequency. To detect the translation a difference is needed and that would require two separate outputs, a forward and a rearward laser output. That being the case there is no need for a three mirror laser, so a straight two-mirror laser with outputs at both ends was proposed.

The necessary requirement for resonance in the two-mirror speedometer is the same as that in the laser gyro, namely a constant wavelength that is an exact integer fraction of the total path length. The total path length is up and back, twice the distance between the mirrors. The resonance is standing wave resonance, with electric nodes at each mirror and at every half wavelength between the mirrors. When at rest there is only one frequency. When in translational motion there are two resonant frequencies, one in the forward moving light waves and the other in the rearward moving light waves.

Figure 3 is a diagram of the laser speedometer moving with speed v as shown. When the laser is at rest, with respect to the light propagating medium, its resonant frequency is $f_0$. There are two resonant frequencies, one above and one below $f_0$, when the laser is moving with velocity v. Inside the laser, light propagates with speed c-v in the forward direction of motion, and with speed c+v in the rearward direction.

The physics of this phenomenon is quite different from that in old optics experiments in which light waves make only one pass around the circuit and there is no resonance. In the laser gyro and in this laser speedometer the resonance is formed by traveling waves that transit the circuit many times placing wave on top of wave. The lasing enhancement of the light waves takes place in the direction of the traveling wave propagation and provides the gain that is necessary to sustain the oscillations.

The frequency of the forward beam is $f_1$, and of the rearward beam is $f_2$. When the resonator is moving forward with speed v, the speed of light inside the laser is c-v in the forward direction and c+v in the rearward direction. The wavelength is constant, so

$$f_1 = \frac{c-v}{\lambda} \tag{10}$$

and

$$f_2 = \frac{c+v}{\lambda} \tag{11}$$

The frequency difference

$$f_2 - f_1 = \frac{2vf_0}{c}. \tag{12}$$

This is the basic equation for the laser speedometer. The difference in frequency at the laser's two outputs is proportional to the speed v. These two output beams are routed by means of mirrors to the readout detector as shown in Figure 3. It converts frequency difference into a speed reading.

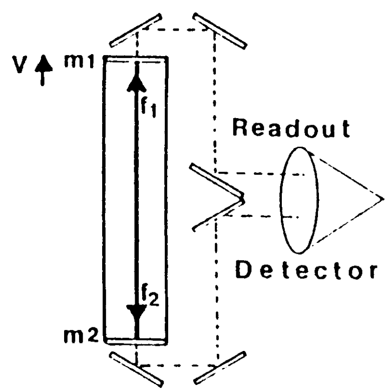


**Figure 3. Laser speedometer.**

It should be noted that these frequency changes with speed are not doppler shifts. There are no doppler shifts in the laser speedometer. Even in the outside routing of the two laser beams from the laser to the output detector there is no doppler shift. That is because the distance between the laser output and the output detector is fixed. There is no doppler shift in a moving system when the distance between the source and receiver is fixed.

### Summary

It has been shown from ordinary time and space physics that the laser gyro generates oscillatory frequencies, sustained by the gain supplied by the lasing process. Not one, but two oscillator frequencies develop when the device is in rotational motion with respect to the space medium. The frequency difference is proportional to the angular velocity. Frequency difference is converted to angular information, useful in navigation.

Of most importance in this paper is the theory of the two-mirror two-output laser speedometer. The same physics, as that in the laser gyro, yields two oscillatory frequencies in its laser cavity as it moves with constant velocity in the space medium. The resonance condition is standing waves with electric nodes at the mirrors between which are equal half-wavelengths. In both the laser gyro and laser speedometer the laser's frequency bandwidth is sufficient to provide the gain at both frequencies, and narrow enough to prevent extraneous resonance frequencies.

The present technology limits this speedometer to low speed. The problem is the limited frequency range of the readout detector. That is a matter of improving technology, not a limitation in the physics of the theory. If this speedometer's detection of constant velocity is verified by experiment, even at low speed, it will falsify Einstein's special theory of relativity.*

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*Dr. Barnes has stated that he would welcome criticism on the concept presented in this paper.

# RADIATIVE EQUILIBRIUM IN AN ATMOSPHERE WITH LARGE WATER VAPOR CONCENTRATIONS*

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### Abstract

*Equilibrium temperatures are found for several hypothetical atmospheres with large water vapor concentrations (vapor pressure from 50 mb to 1013 mb) at stratospheric levels. Radiative equilibrium is computed using the Air Force radiation algorithm LOWTRAN 7 with no clouds or aerosols. The initial starting condition of an isothermal atmosphere at about -100°C warms to over +100°C at the base of the water vapor layer and becomes isothermal to the surface within 1 to 2 years. Temperatures are sufficiently warm to maintain large quantities of water in vapor form but are too hot for the surface to be habitable. The temperature and pressure in the highest levels are such that cirrus clouds will form. These clouds would reflect a large portion of incoming solar radiation, thereby likely altering atmospheric stability and surface temperature.*

### Introduction

Climate modelers have varied the concentration of carbon dioxide in order to explain the evidence for different climate regimes in the earth's past. However, few have seriously considered large water vapor concentrations at stratospheric levels. The idea that the atmosphere of the ancient earth may have been overlain by water in one phase or another was apparently first suggested, at least in modern times, by Vail (1965). For Vail, many water canopies existed throughout earth's long history. They resulted from out-gassing of the earth's interior, and their collapse over geologic time formed the oceans. The idea of a vapor canopy appealed to creationists, where it took root and began to be incorporated by them in models of earth history (Whitcomb and Morris, 1961). A water vapor canopy played an important part in their model. It continues to have a major role in many creationist models of the ancient earth (e.g. Dillow, 1982).

There is no direct support for the existence of a water vapor canopy surrounding the earth in the past. However, a survey of the solar system reveals that five of the nine planets, including the one closest to us in distance and size, Venus, have thick cloud canopies. An important effect of canopies in the solar system today is to moderate temperatures beneath them. Planets that do not have canopies show a much wider variance in temperature-diurnally, yearly, and latitudinally. Earth is characterized by a fairly large and permanent temperature gradient between its equator and poles. This temperature gradient produces a pressure gradient, which becomes the driving force behind

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