1) Tuning Fork Style MEMS Vibratory Gyroscope [1]

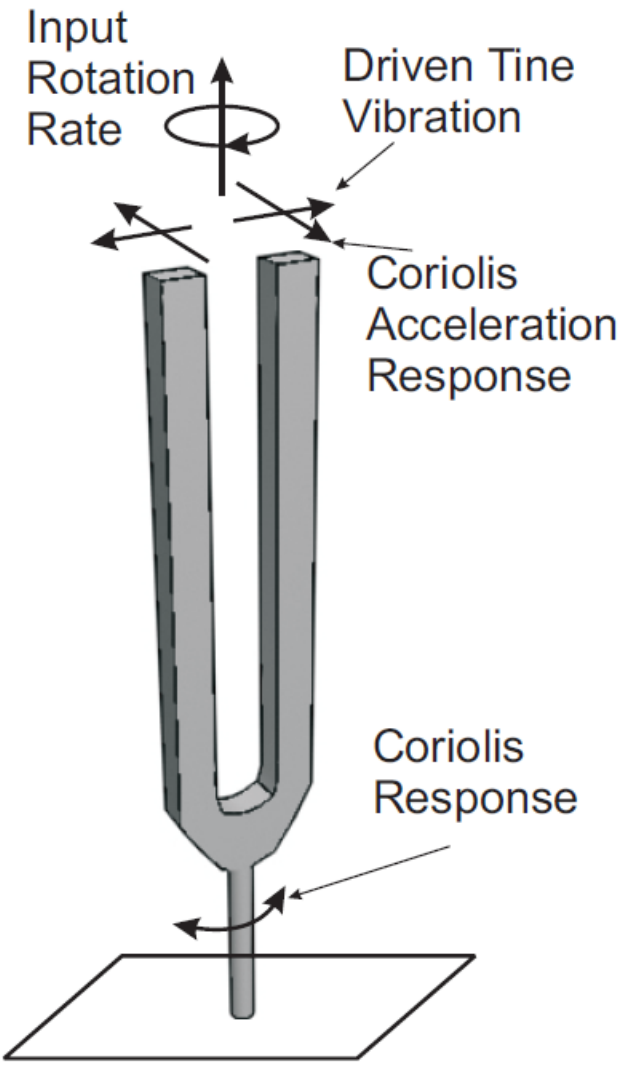


Fig. 1. Tuning Fork Gyroscope. Commonly used Type II gyro configuration

Type II MEMS vibratory gyroscopes: measure angular rate

Often the vibrating structure is made of a material such as quartz using piezoelectric actuation/detection

Example tuning fork gyroscope [2]:

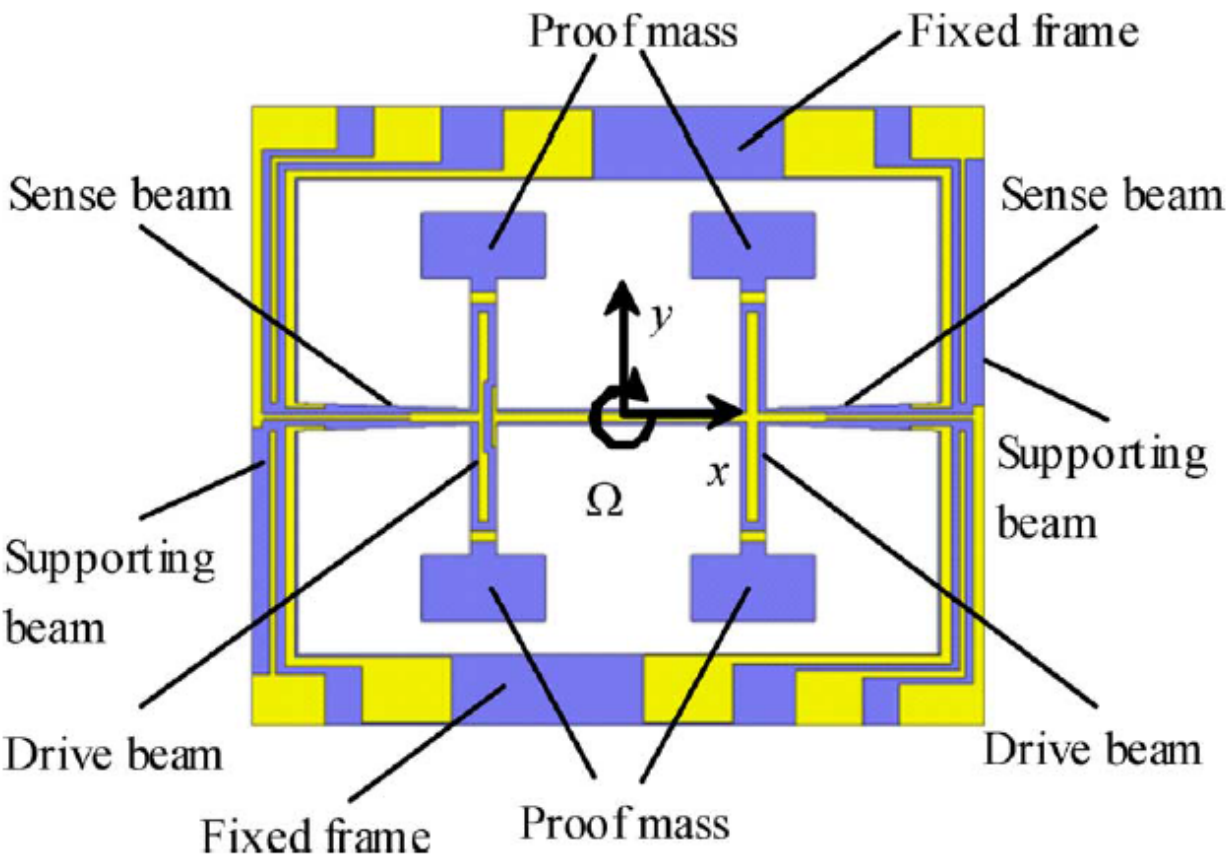
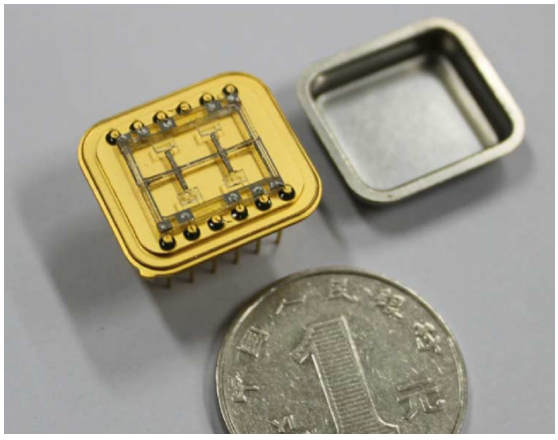


Fig. 1. Novel gyroscope's structure.



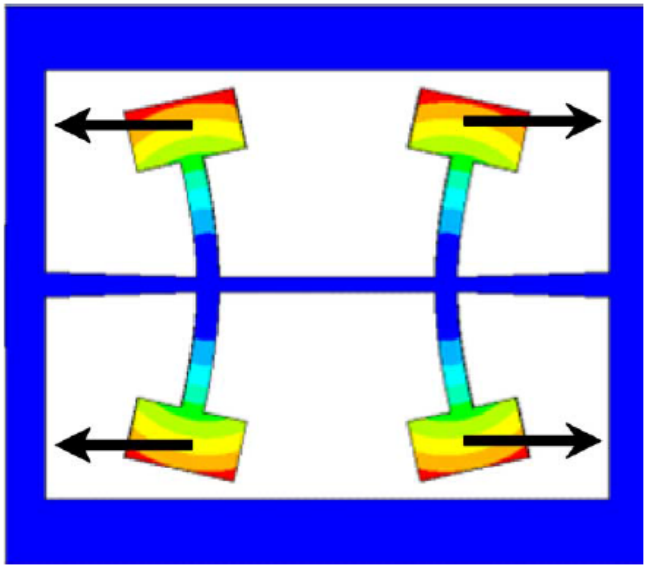


Fig. 3. Drive mode of the gyroscope.

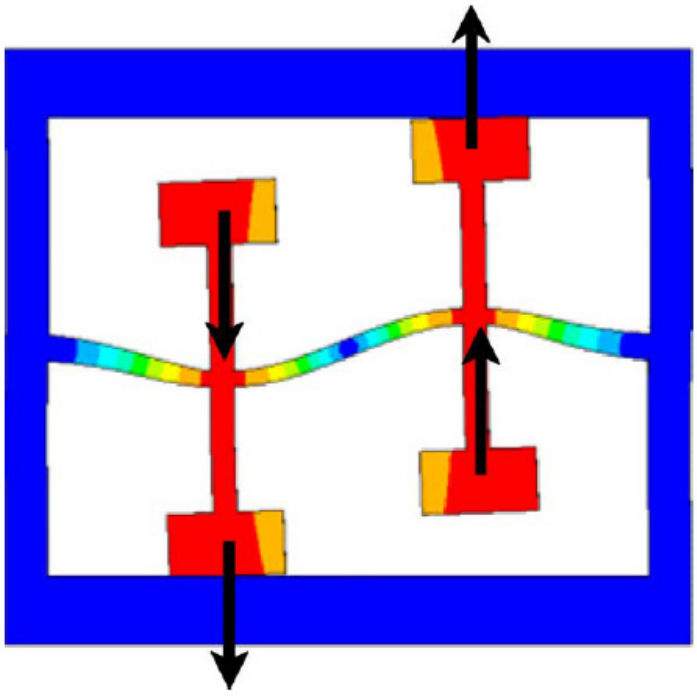


Fig. 4. Sense mode of the gyroscope.

2) Type I MEMS Vibratory Gyroscopes: measure rotation angle: Angle of presession is proportional to angle of rotation [1]

Usually implemented as a vibrating shell or disk. Work great in theory, not so well in practice

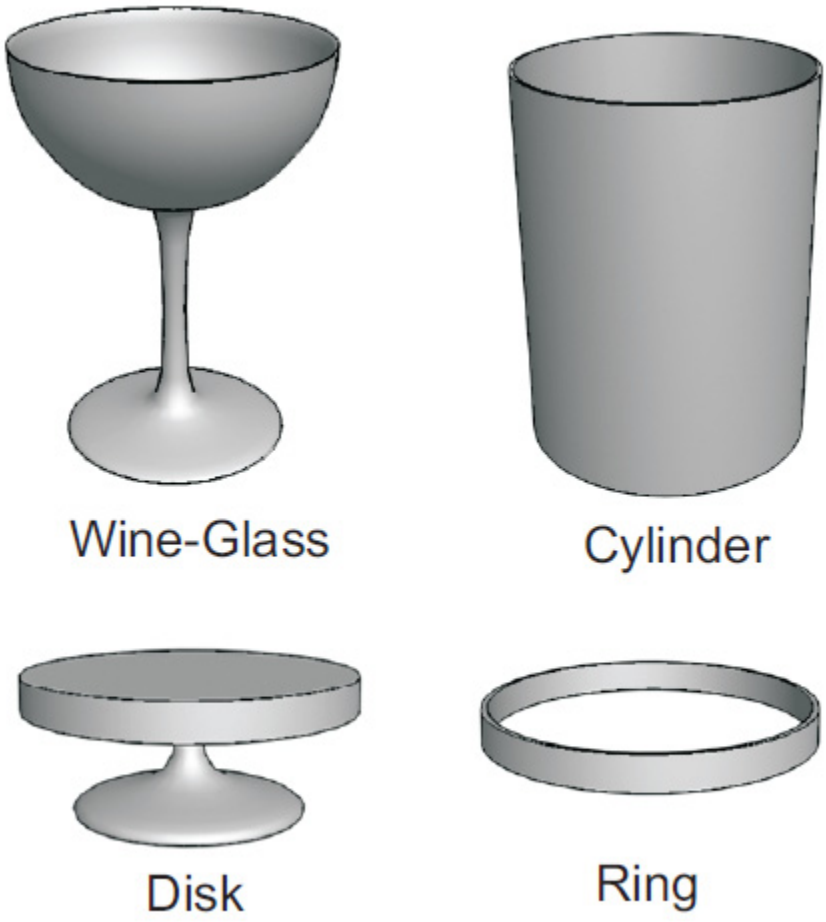
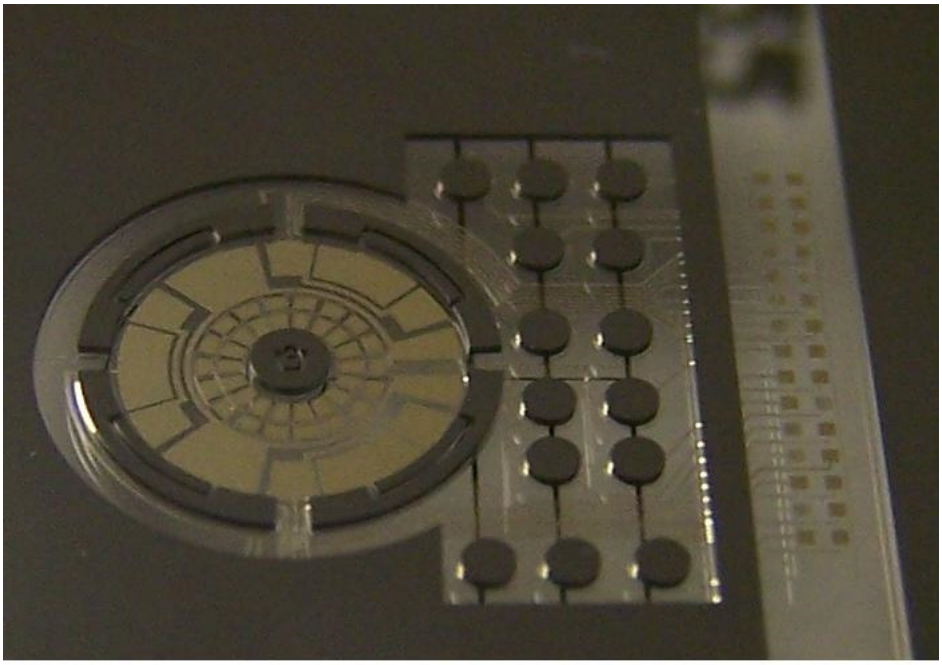


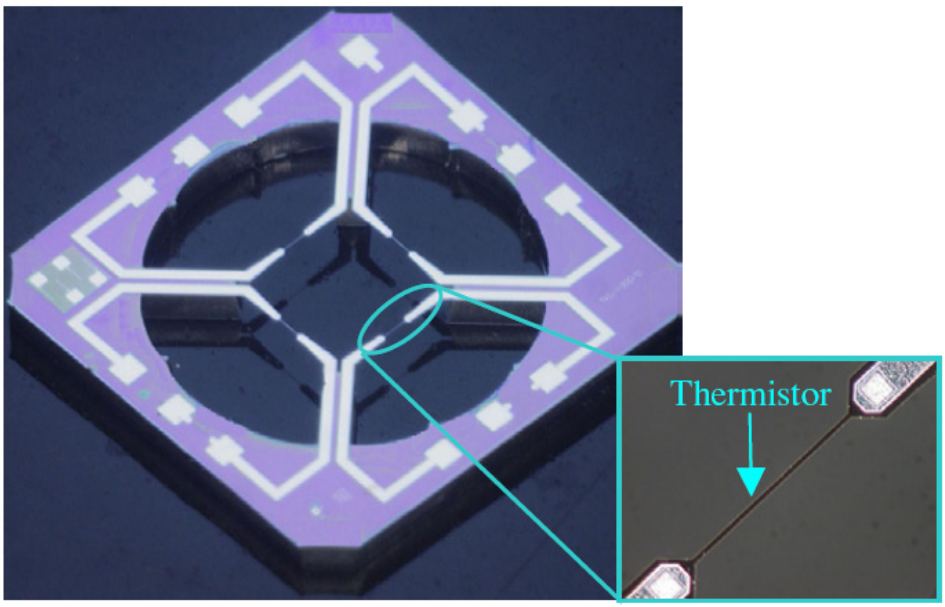
Fig. 2. Examples of vibrating shell gyroscopes

3) Levitated Proof Mass MEMS Gyros [3]

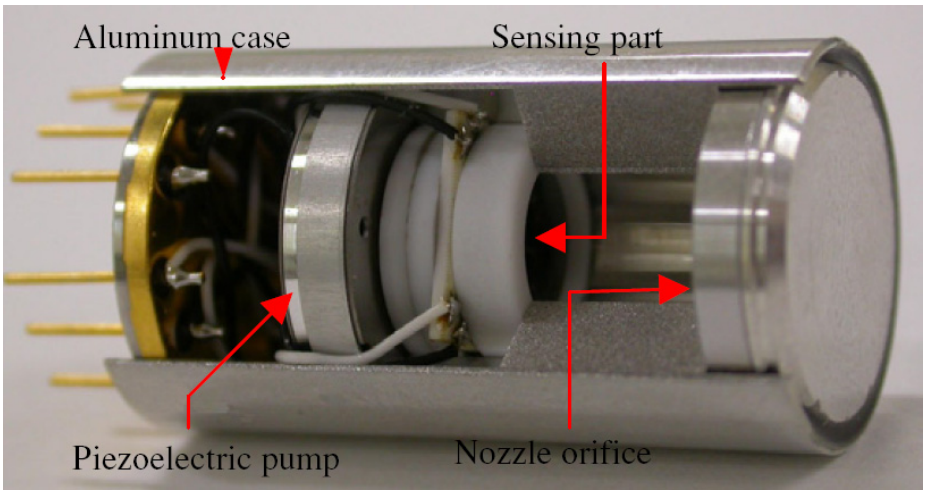


Proof mass electrostatically levitated and rotated at high speed. Multi-axis control system maintains position in surrounding shell when exposed to translational acceleration or rotation. A single chip IMU in theory. Many issues: fabrication tolerance, complex electronic controllers, start-up, mechanical shock resistance, survival in unpowered state, etc.

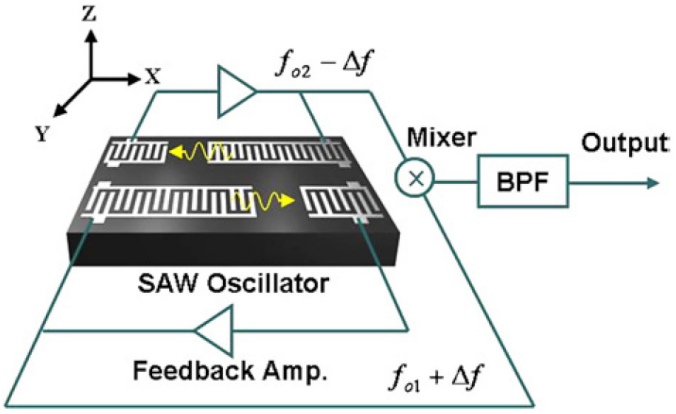
4) Hot Gas 2-axis MEMS Gyro [4]

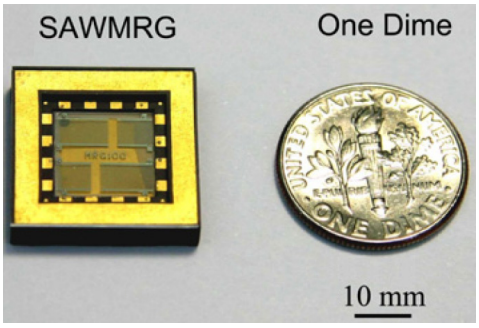


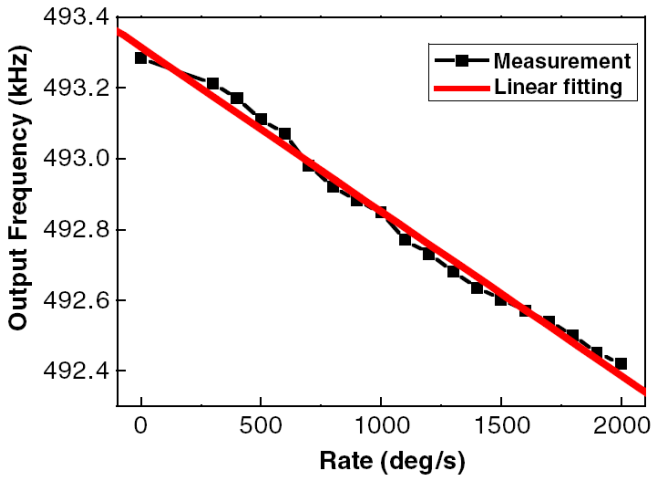
Hot gas jet blown between MEMS 2-axis thermistor. Rotation effectively deflects jet from being in the center of the thermistor array, resulting in a proportional temperature difference



5) SAW Based MEMS Gyro [5]



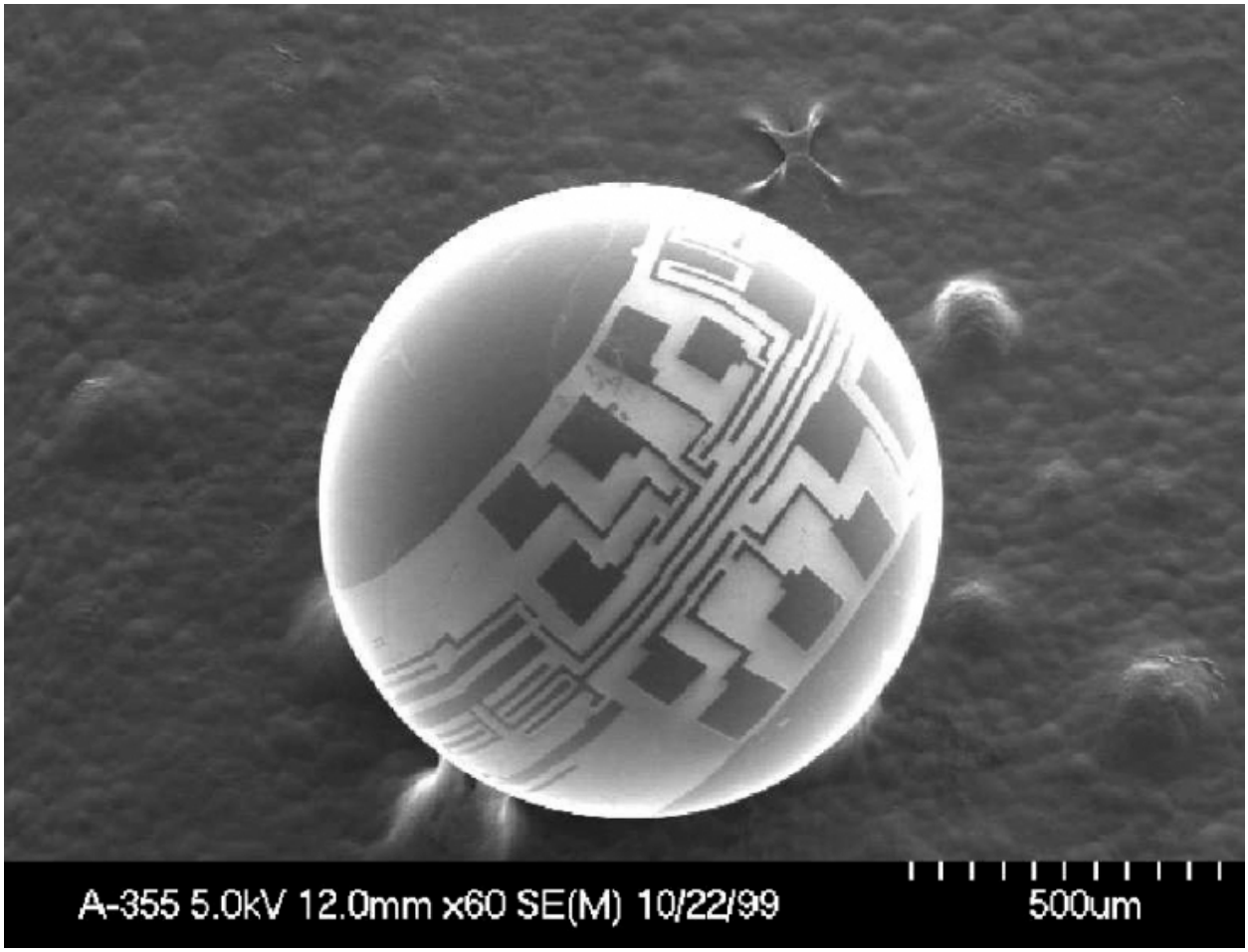




2 acoustic waves launched in opposite directions along quartz substrate (SAW delay line oscillators). Angular rate about z-axis causes opposite frequency shift in the two oscillators (due to the Coriolis force) that is detected to measure angular rate. Nominal oscillator frequency is 98.6MHz – well outside of mechanical vibration/acoustic components in the operating environment

6) Ball Semiconductor

Ball Semiconductor manufactures spherical semiconductor chips. Has been theorized that they can use a spherical IC in a hollow spherical shell, levitate it and use it to measure acceleration and rotation.



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[2] Xuezhong Wu, Liqiang Xie, Jianchun Xing, Peitao Dong, Haoxu Wang, and Jianbin Su , “A Z-Axis Quartz Tuning Fork Micromachined Gyroscope Based on Shear Stress Detection”, IEEE SENSORS JOURNAL, VOL. 12, NO. 5, MAY 2012.

[3] Charles Ellis, Auburn University

[4] Van Thanh Dau, Dzung Viet Dao, Tatsuo Shiozawa, Hideo Kumagai and Susumu Sugiyama, “Development of a dual-axis thermal convective gas gyroscope,” J. Micromech. Microeng., Vol. 16, No. 6, July 2006, pp. 1301-1306.

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