LAGEOS COLLECTION
(Laser Geodynamics Satellite)
University of Alabama in Huntsville

Contact Information:
Department of Archives and Special Collections
M. Louis Salmon Library
301 Sparkman Dr.
University of Alabama in Huntsville
Huntsville, AL 35899
256 824 6523
colemana@email.uah.edu

Table of Contents
Descriptive Summary
Title LAGEOS Collection
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Identification LAGEOS Collection
Index Donated by Charles A. Lundquist, 2003
Created by Charles A. Lundquist, 2003
Microsoft Access

Background
LAGEOS I (Laser Geodynamics Satellite), launched in 1976, is a passive satellite designed to help scientists study the geodynamics of Earth. Geodynamics is the study of the motion of the earth and the forces and processes active in the interior of the Earth and how they affect the features of the Earth’s crust.

An unusual feature of the Lageos Program is its international evolution. After Lageos I was built and launched by the NASA Marshall Space Flight Center, its success motivated the Italian Space Agency to undertake production of subsequent Lageos satellites. These were built using the MSFC drawings and were as identical to Lageos I as possible. They were launched into orbits like that of Lageos I, but with complementary inclinations that facilitated investigation of relativistic effects on the orbits. Hence the Lageos Program evolved from a U.S. program into an Italian Program. Also, the laser ranging to the satellites was performed by ground stations of many nations from the beginning.

Another unique aspect of the Lageos Program is that the retroreflectors on these inert satellites are expected to remain usable for hundreds of years, and the satellites themselves will stay in orbit for many thousands of years. Thus at the centennials of the Lageos launches, range data will probably continue to be generated and used for scientific investigations. This unusual longevity of the Lageos Program makes an archive of its early years valuable to future generations using the satellites.

Scope and Content
The publication dates of the documents in the Lageos Collection range from 1971-2003. Not intended to be comprehensive, the emphasis of the Lageos Collection is on programmatic and historic documents rather than the scientific papers which are readily found through the standard scientific indices.

Restrictions
No restrictions for use within the Library building.
Copyright Information: Collections are protected by the U. S. Copyright Law (Title U.S. Code 17). Reproduction of any item must contain the complete citation of the original
1. **Title** The SAO EarthPhysics Satellite Def.Study Vol I-III  
**Author** MSFC Program Dev. Staff  
**Date Published** 9/30/1971  
**Source** Coordinated by Program  
**Document Number** NASA TM X-64632  
**Abstract** As a result of the mutual interest within OMSF and OSSA in the identification of beneficial missions utilizing unassigned space hardware, a limited Phase B study was undertaken at MSFC to determine the merit and feasibility of launching a proposed Earth Physics Satellite with Apollo-type hardware. Simultaneously, the Smithsonian Astrophysical Observatory accomplished a Phase B definition of the proposed satellite.

2. **Title** NASA’s LAGEOS to Measure Earth Motions and Strain  
**Author** publication staff writer  
**Date Published** 12/12/1973  
**Source** MARSHALL STAR Vol 14 No 14 p  
**Document Number**  
**Abstract** NASA is planning a 1976 launch of a Laser Geodynamic Satellite (LAGEOS) which, according to space agency officials, "will track the Earth relative to the satellite, in contrast to the traditional case of tracking a satellite relative to the Earth. …A LAGEOS Task Team, managed by Donald R. Bowden, has been established within Program Development (at MSFC).

3. **Title** LAGEOS, VOL 1  
**Author** Charles A. Lundquist, compiler  
**Date Published** 6/30/1974  
**Source** Many sources  
**Document Number**  
**Abstract** This is a binder into which a variety of documents pertaining to the early history of the LAGEOS program have been compiled (492 pages). The period covered is roughly 1973 through mid 1974. There is a table of contents in the front of the binder.

4. **Title** The Lageos System  
**Author** Joseph W. Siry  
**Date Published** 12/31/1975  
**Source** NASA  
**Document Number** NASA TM X-73072  
**Abstract** The LAGEOS system is defined and its rationale is developed. This report was prepared in February 1974 and served as the basis of the LAGEOS Satellite Program development.

5. **Title** Annotated Fabrication Photographs  
**Author** None  
**Date Published** 12/31/1975  
**Source** NASA  
**Document Number**  
**Abstract** This is a collection of photographs taken during the fabrication of the LAGEOS satellite.
<table>
<thead>
<tr>
<th>Title</th>
<th>The Laser Geodynamic Satellite LAGEOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author</td>
<td>Unknown</td>
</tr>
<tr>
<td>Source</td>
<td>Working paper, NASA</td>
</tr>
<tr>
<td>Date Published</td>
<td>12/31/1975</td>
</tr>
<tr>
<td>Abstract</td>
<td>The Earth and Ocean Applications Program (EODAP) is an applications program based on the disciplines of earth and ocean dynamics. Its primary goals are to identify, develop and demonstrate relevant space techniques that will contribute significantly to the development and validation of predictive models for earthquake hazard alleviation, ocean-surface conditions and ocean circulation.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th>LAGEOS, Vol 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author</td>
<td>Charles A. Lundquist, compiler</td>
</tr>
<tr>
<td>Source</td>
<td>Many sources</td>
</tr>
<tr>
<td>Date Published</td>
<td>3/31/1976</td>
</tr>
<tr>
<td>Abstract</td>
<td>This is a binder into which a variety of documents pertaining to the LAGEOS Program have been compiled (386 pages). The period covered is roughly the last half of 1974 through the first quarter of 1976. There is a Table of Contents in the front of the binder.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th>Press Kit, Project LAGEOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author</td>
<td>NASA News</td>
</tr>
<tr>
<td>Source</td>
<td>NASA Headquarters</td>
</tr>
<tr>
<td>Date Published</td>
<td>4/15/1976</td>
</tr>
<tr>
<td>Abstract</td>
<td>Sections of Press Release: General Release, Mission Objectives, Program Background, Collecting Data from LAGEOS, LAGEOS Description, Message to the Future, Launch Sequence, Delta Launch Vehicle Description, Launch Operations, LAGEOS/Delta Program/Project Management.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th>Satellite to Monitor Earth's Crust</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author</td>
<td>publication staff writer</td>
</tr>
<tr>
<td>Source</td>
<td>NASA ACTIVITIES Vol 7 No 4 p 9</td>
</tr>
<tr>
<td>Date Published</td>
<td>4/30/1976</td>
</tr>
<tr>
<td>Abstract</td>
<td>A geophysical research satellite expected to survive in space for several million years passed scientific testing recently at NASA's Goddard Space Flight Center preparatory to a May launch from the Western Test Range. LAGEOS (For Laser Geodynamic Satellite) is expected to be of significant aid to scientists seeking to predict earthquakes. …The LAGEOS project is managed for NASA's Office of Applications by the Marshall Space Flight Center.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th>Lageos Launch Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author</td>
<td>McDonnell Douglas Corporation</td>
</tr>
<tr>
<td>Source</td>
<td>McDonnell Douglas Corp.</td>
</tr>
<tr>
<td>Date Published</td>
<td>5/1/1976</td>
</tr>
<tr>
<td>Abstract</td>
<td>This is a transparent color illustration of the Lageos Launch Vehicle. Components are annotated in the cut-away illustration.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th>LAGEOS Carries Perkin-Elmer Retroreflectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author</td>
<td>Charles C. Dayton</td>
</tr>
<tr>
<td>Source</td>
<td>Perkin-Elmer Corporation</td>
</tr>
<tr>
<td>Date Published</td>
<td>5/3/1976</td>
</tr>
<tr>
<td>Abstract</td>
<td>The Laser Geodynamics Satellite (LAGEOS) ... is encrusted with 426 highly precise optical elements. These elements, called retroreflectors, produced by the Perkin-Elmer Corporation, Norwalk, Connecticut, ... are the key to the passive satellites' effectiveness. They are designed to accurately reflect laser light beamed at them from earth directly back to an earth based ground station.</td>
</tr>
</tbody>
</table>
12
Title: LAGEOS, Vol 3
Author: Charles A. Lundquist, compiler
Date Published: 5/4/1976
Source: many sources
Abstract: This is a binder into which a variety of documents have been compiled (412 pages). The period covered begins with launch preparations and launch on May 4, 1976. Post-launch documents over the following several years are included. There is a Table of Contents in the front of the binder.

13
Title: Golf Ball in the Sky
Author: staff writer
Date Published: 5/17/1976
Source: article in TIME, p 57
Abstract: Perched in the nose of a Delta rocket, one of the simplest satellites ever built by the U.S. roared of the launch pad at Vandenberg Air Force Base last week begin an 8 million-year journey in space. …Because LAGEOS is expected to remain in orbit for so long, NASA has placed aboard it two stainless-steel sheets each etched with a message conceived by astrophysicist Carl Sagan of Cornell University, designed to inform extraterrestrial visitors or future inhabitants of the earth about the

14
Title: Laser Geodynamic Satellite-1 Post Launch Report #1
Author: Leonard Jaffe
Date Published: 5/27/1976
Source: Memorandum from Code E to A
Abstract: LAGEOS was launched into orbit on May 4 ... The early phase of the mission will validate laser ranging techniques and is already underway beginning with the first laser returns acquired by the Smithsonian's Mount Hopkins Observatory on May 6, 1976. ...

15
Title: Lageos, Laser Geodynamic Satellite
Author: Marshall Space Flight Center
Date Published: 5/31/1976
Source: NASA Marshall Center
Abstract: ...The satellite is performing "exceedingly well" according to reports. …The 10-centimeter accuracy goal prescribed to be attained within one year after its May 4, 1976 launch was in fact attained within the first two weeks.

16
Title: R. L. Spencer Returns to Marshall Center
Author: publication staff writer
Date Published: 6/16/1976
Source: NASA MARSHALL STAR, Vol 16
Abstract: Robert L. Spencer, who served as Lageos Program manager in NASA Headquarters for the past two years has been reassigned to the staff of the Payloads Studies Office at Marshall Center. At Headquarters, Spencer was in the Special Projects Office, Office of Applications.

17
Title: Lageos Orbital Acquisition and Initial Assessment
Author: M.R.Pearlman, J.M.Thorp, D.A.Arnold
Date Published: 6/18/1976
Source: Center for Astrophysics
Abstract: The Smithsonian Astrophysical Observatory (SAO) Baker-Nunn camera and laser network provided the orbital acquisition for Lageos. Signal-strength and range-noise measurements made by SAO and NASA show that the satellite is functioning as anticipated. Epoc June 7.0; inclination 109.8585 deg; eccentricity 0.003929; apogee 5941.9 km; perigee 5845.4 km; period 225.4706 min; semimajor axis 12271.790 km.
**18. The Shape of the Earth**

**Title:** The Shape of the Earth  
**Author:** Desmond King-Hele  
**Date Published:** 6/25/1976  
**Source:** SCIENCE, Vol 192 p 1293-1300  
**Abstract:** The June 25, 1976 issue of SCIENCE has a photograph of LAGEOS on its cover. The general article by King-Hele mentions LAGEOS on p 1299.

**19. Lageos is Launched Successfully**

**Title:** Lageos is Launched Successfully  
**Author:** publication staff writer  
**Date Published:** 7/31/1976  
**Source:** NASA ACTIVITIES Vol 7 No 7 p 5  
**Abstract:** A Laser Geodynamic Satellite that will serve as a tool for obtaining information on Earth's crustal movements, polar motion, solid Earth tides and precise locations on various spots on the planet was launched May 4 from the Western Test Range by a three-stage Delta vehicle. Lageos is the first NASA spacecraft dedicated exclusively to laser ranging.

**20. Message for the Future, page 10**

**Title:** Message for the Future, page 10  
**Author:** Arthur Fisher  
**Date Published:** 7/31/1976  
**Source:** Science Newsfront section,  
**Abstract:** Last May, NASA launched a spacecraft with a curious fillip: a greeting card to whatever creatures may be inhabiting the Earth some eight million or more years in the future. The satellite builders at Bendix Corporation and NASA believe it will not be braked by the atmosphere for at least eight million years. They realized that here was a unique opportunity to communicate with the future. Dr Carl Sagan of Cornell University designed a stainless-steel plate carrying a message that was attached to the satellite.

**21. Satellite Laser Ranging Systems Validation Plan**

**Title:** Satellite Laser Ranging Systems Validation Plan  
**Author:** NASA Goddard Space Flight Center  
**Date Published:** 8/31/1976  
**Source:** NASA Goddard  
**Abstract:** Overall Objectives: Verify that dynamical techniques of satellite geodesy can measure inter-site distances of several hundred to several thousand kilometers and pulsar motion with a precision of about 5 centimeters.

**22. Typical MOBLAS Installation**

**Title:** Typical MOBLAS Installation  
**Author:** Larry E. Hare  
**Date Published:** 9/22/1976  
**Source:** Bendix Field Engineering  
**Abstract:** The two principal elements of a mobile laser tracking station are shown in an artist's rendering. In the foreground is the van containing the laser source and telescope ... The second van contains the surveillance radar set used to ensure that no aircraft are likely to accidently enter the beam of the laser transmitter. Bendix Field Engineering Corporation currently operates three of these mobile tracking stations.

**23. The Lageos Satellite**

**Title:** The Lageos Satellite  
**Author:** C.W. Johnson, C.A. Lundquist and J.L.  
**Date Published:** 10/10/1976  
**Source:** IAF XXVII Congress  
**Abstract:** The fundamental concept of Lageos is a long-lived, dense, electrically and mechanically inert spherical satellite with its surface speckled with retroreflecting cube corners, designed such that range measurements between duly equipped laser ground stations and the satellite are possible with an ultimate accuracy of 2 cm averaged. The Lageos concept requires that the satellite be placed in an orbit for which an ephemeris can be determined ultimately to a 5 cm rms uncertainty for a 24-hour arc.
<table>
<thead>
<tr>
<th>Title</th>
<th>LAGEOS, A Geodynamics Tool in the Making</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author</td>
<td>Robert L. Spencer</td>
</tr>
<tr>
<td>Source</td>
<td>Manuscript for JOURNAL OF</td>
</tr>
<tr>
<td>Date Published</td>
<td>12/9/1976</td>
</tr>
<tr>
<td>Abstract</td>
<td>This article presents an overview of the Lageos Project from its inception through the first six months after launch. Brief insight is given into the justification of the project, the evolution of the measuring system and the satellite design. A description of the satellite's message to the future is included along with near-term plans for the associated geodynamics activities.</td>
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<table>
<thead>
<tr>
<th>Title</th>
<th>LAGEOS pla</th>
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<tbody>
<tr>
<td>Author</td>
<td>Bendix Aerospace Systems Division</td>
</tr>
<tr>
<td>Source</td>
<td>Director of Marketing, Bendix</td>
</tr>
<tr>
<td>Date Published</td>
<td>12/31/1976</td>
</tr>
<tr>
<td>Abstract</td>
<td>This is an eight page brochure prepared by the Bendix Corporation, Aerospace Systems Division, post launch of LAGEOS. The Bendix Aerospace Systems Division, under contract to NASA MSFC, was the integration contractor for the satellite. Page 8 of the brochure has a replica of the LAGEOS plaque.</td>
</tr>
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<table>
<thead>
<tr>
<th>Title</th>
<th>Lageos Press Clippings</th>
</tr>
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<tbody>
<tr>
<td>Author</td>
<td>various publications</td>
</tr>
<tr>
<td>Date Published</td>
<td>12/31/1976</td>
</tr>
<tr>
<td>Abstract</td>
<td>This is an envelope of LAGEOS press clippings from various dates in 1976</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Title</th>
<th>…Transfer Function of the Lageos Retroreflector Ar</th>
</tr>
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<tbody>
<tr>
<td>Author</td>
<td>Arnold, David A.</td>
</tr>
<tr>
<td>Source</td>
<td>Smithsonian Astrophysical</td>
</tr>
<tr>
<td>Date Published</td>
<td>5/31/1978</td>
</tr>
<tr>
<td>Document Number</td>
<td>Grant NGR 09-015-002</td>
</tr>
<tr>
<td>Abstract</td>
<td>The transfer function of the retroreflector array carried by the LAGEOS satellite (1976 39A) has been computed at three wavelengths: 5230, 6943, and 106000 Å. The range correction is given for extrapolating laser range measurements to the center of gravity of the satellite. The reflectivity of the array has been computed for estimating laser-echosignal strengths.</td>
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<table>
<thead>
<tr>
<th>Title</th>
<th>Method of Calculating Retro.-Array Trans. Fun.</th>
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<tbody>
<tr>
<td>Author</td>
<td>Arnold, David A.</td>
</tr>
<tr>
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<td>Smithsonian Astrophysical</td>
</tr>
<tr>
<td>Date Published</td>
<td>12/31/1978</td>
</tr>
<tr>
<td>Document Number</td>
<td>SAO Special Report 382</td>
</tr>
<tr>
<td>Abstract</td>
<td>This report presents methods for computing the properties of the reflection from a cube-corner array when it is illuminated by a laser pulse. Such information is useful in the design of satellite retroreflector arrays and ground tracking equipment as well as in the analysis of the data obtained. The methods derived include the effects of coherent interference, diffraction, polarization and dihedral-angle offsets.</td>
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<table>
<thead>
<tr>
<th>Title</th>
<th>Lageos Orbital Analysis in Support of Validation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author</td>
<td>Gaposchkin, E. M.</td>
</tr>
<tr>
<td>Source</td>
<td>Smithsonian Astrophysical</td>
</tr>
<tr>
<td>Date Published</td>
<td>4/30/1979</td>
</tr>
<tr>
<td>Document Number</td>
<td>Grant NSG 5261 Final</td>
</tr>
<tr>
<td>Abstract</td>
<td>The Laser Geodynamic Satellite (Lageos) was launched on May 8, 1976, with an objective to make highly accurate measurements of the geocentric coordinates on the earth's surface, tectonic plate motion, polar motion, and earth tides by using precision laser range data. Analysis of the first 2 years of data is complete. The results indicate that the design goals of the satellite can be met with continued model development.</td>
</tr>
</tbody>
</table>
30 Title: A Refined Gravity Model from Lageos (GEM-L2)  
Author: F.J. Lerch, S.M. Klosko, G.B. Patel  
Date Published: 11/30/1982  
Source: Geophys Res Letters V 9 p  
Abstract: A refined gravity field model, Goddard Earth Model GEM-L2, has been derived using the Lageos orbital data yielding better baseline measurements for the analysis of tectonic plate motion. This field also contributes to an improved understanding of long wavelength features, such as the sea slope across broad ocean basins, through its significant improvement of the long wavelength geoid.

31 Title: Applications of Range-Differencing to Lageos  
Author: Erricos C. Pavlis  
Date Published: 12/31/1982  
Source: Ohio State U, Research  
Abstract: This investigation studies the possibility of improving the accuracy of geodetic results by use of simultaneous observed ranges to Lageos, in a differencing mode, from pairs of stations.

32 Title: Marshall Space Flight Ctr., 25 Anniversary Report  
Author: W. R. Lucas  
Date Published: 7/1/1985  
Source: Marshall Space Flight Center  
Abstract: Page 37 of the 25th Anniversary Report of MSFC discusses the Lageos program and how it fit into the MSFC program assignments.

33 Title: Secular decrease of semimajor axis of LAGEOS orbit  
Author: several including D.P. Rubincam; Alfonso et al  
Date Published: 9/30/1985  
Source: collected from several sources  
Abstract: This is a notebook containing copies of collected references on the secular decrease of the semimajor axis of the orbit of Lageos. The first reference is by D.P. Rubincam (1982). The last is by Alfonso et al (1985).

34 Title: Spotlight Lageos 2  
Author: Aeritalia Space Systems Group  
Date Published: 6/30/1987  
Source: Aeritalia Societa Aerospaziale  
Abstract: A second Laser Geodynamic Satellite, LAGEOS 2, is being developed in Italy under a joint agreement between the Italian and American space agencies. The AERITALIA SPACE SYSTEMS GROUP is the prime contractor for LAGEOS 2 which is similar to LAGEOS 1 launched by NASA in 1976 for space geodesy.

35 Title: ... Air and Water Mass Redistribution Effects  
Author: Roberto Gutierrez and Clark R. Wilson  
Date Published: 9/30/1987  
Source: Geophys Res Letters, v 14 p  
Abstract: We computed zonal geopotential coefficients from average seasonal variations in global air and water mass distributions. These coefficients are used to predict the seasonal variations of LAGEOS' and Starlette's orbital node, delta Omega, and the seasonal delta J3 for Starlette. A comparison of these predictions with the observed values indicates that air pressure and, to a lesser extent, water storage may be responsible for a large portion of the currently unmodeled variation in the earth's gravity field.
Title: Research Announcement Lageos II  
Author: L.A. Fisk  
Date Published: 2/1/1988  
Source: NASA  
Document Number: NRA 88-OSSA-1  
Abstract: NASA Research Announcement soliciting proposals for basic research in the use of ground-based satellite laser ranging to Lageos II for the period ending August 1, 1988.

Title: Simulation of Lageos-3 Meas. of Lense-Thirring P.  
Author: M.M. Watkins, B.D. Tapley, R.J. Eanes and  
Date Published: 12/31/1989  
Source: Ctr. for Space Res. U of Texas  
Document Number:  
Abstract: The dragging of inertial frames is a consequence of Einstein's General Relativity. ... The dragging of the orbital plane (and the orbital angular momentum) of a test particle orbiting the field of a rotating body is included among the various effects due to the gravitomagnetic field. This paper proposes a new Lageos-type satellite (Lageos 3) which is physically identical to Lageos-1 and is placed in an orbit with identical altitude and eccentricity and with an inclination supplementary to the Lageos-1 orbit.

Title: ... Parameters from 7 Years of Data on Lageos  
Author: Pascal Gegout and Anny Cazenave  
Date Published: 9/30/1991  
Source: Geophys Res Letters V 18  
Document Number: Paper No 91GL01801  
Abstract: Seven years (1984 through 1990) of Laser data on Lageos have been analysed to recover absolute station velocities and J2. Relative motions between stations located in stable tectonic regions agree well with the NUVEL-1 model predictions within 5mm/yr rms.

Title: LAGEOS II brochure  
Author: Miriam Baltuck, Lou Caudill  
Date Published: 11/2/1992  
Source: NASA cover letter, Dear Colleague  
Document Number:  
Abstract: On October 23, 1992 NASA deployed the Italian Space Agency (ASI)-constructed Italian Research Interim Stage (IRIS) booster holding the LAGEOS II satellite from the Shuttle Columbia. IRIS took LAGEOS II from Shuttle altitude to its nominal orbital altitude of 5,900 km, where a second small booster put Lageos II into a circular orbit.

Title: Lageos Laser Ranging Contributions to Geodynamics  
Author: BDTapley, BESchutz, RJEanes, JCRies,  
Date Published: 12/31/1993  
Source: American Geophysical Union  
Document Number: Earth Dynamics  
Abstract: During the period between Lageos launch through completion of the Crustal Dynamics Project at the end of 1991, the satellite ranging technique has evolved into one of the fundamental geophysical and geodetic measurement techniques.

Title: A Numerical Solution for Lageos Thermal Thrust  
Author: Victor J. Slabinski  
Date Published: 12/31/1997  
Source: Celestial Mechanics and Dynam.  
Document Number:  
Abstract: We report the results of detailed numerical calculations of the thrust on the rapidly spinning LAGEOS spacecraft. The thrust results from anisotropic emission of thermal radiation from the surface. LAGEOS is a good test for such calculations because of its relatively simple structure and because precise orbit determination based on laser ranging give observed thrust effects of comparison.
**42. Meas. of Lense-Thirring Eff. with Two Satellites**

**Title:**

Meas. of Lense-Thirring Eff. with Two Satellites

**Author:**

Ignazio Ciufolini et al

**Date Published:**


**Source:**

Science, V 279, p 2100-2103

**Abstract:**

The Lense-Thirring effect, a tiny perturbation of the orbit of a particle caused by the spin of the attracting body, was accurately measured with the use of the data of two laser-ranged satellites, LAGEOS and LAGEOS II, and the Earth gravitational model EGM-96. The parameter \( \mu \) which measures the strength of the Lense-Thirring effect was found to be 1.1 plus or minus 0.2; general relativity predicts \( \mu = 1 \).