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Laboratori Nazionali di Frascati

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# My collaboration with Edoardo Amaldi and its impact on Gravitational Waves

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**Abstract**

During one of our daily coffees, Edoardo Amaldi told me I was the researcher with whom he had collaborated the longest. This compels me to describe how our collaboration developed from the beginning and what fruits it brought in the search for gravitational waves. I remember, among the myriad events that occurred during the more than a thousand days spent collaborating with Edoardo, some events that most struck me.

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## 1 The Beginning

My interaction with Edoardo Amaldi began in 1956 after I obtained my *laurea* degree. I remember he said I could be the computer man. I took a Fortran manual and I dropped it because it bothered me[1].

After graduating with an experimental thesis in the structure of matter, having performed cryogenic experiments at the INFN in Frascati (the first Italian researcher to work in Frascati), after having spent some time in the group of nuclear emulsions, I manifested interest in the new science of space. In 1959 I applied to NASA for a post-doctor.

In the spring of 1959 Edoardo Amaldi was at a conference in Russia where he met James Van Allen, who had just discovered Earth's radiation belts, and spoke to him of a student from Rome who wanted to start studying the physics of space. Edoardo must have spoken highly of me (although he knew me little) because after a couple of weeks, I received a letter from Van Allen with an offer for a position as research assistant at the University of Iowa.

I remember that, before I left, Edoardo told me I was too polite and that, in America, I should have done what they told me to do even if it wasn't what I wanted.

I went to Iowa City and found out that I could also enroll as a student at the University of Iowa to get the PhD, which I obtained on February 3, 1962.

## 2 Assistant to Edoardo Amaldi

Back in Italy I discovered that I had a position as INFN researcher (Edoardo Amaldi was at that time the INFN President). Soon after they told me to participate in a competition for a post of assistant to Amaldi. There were three contestants. My test was not the best but, strangely, Amaldi chose me.

Soon after, I spent a year at NASA at the Greenbelt NASA Center. Here I met Dave Evans who had worked at the Bendix Corporation where he had invented the channeltron, continuous photomultiplier. This detector of light and low energy electrons and protons (like those of the solar wind) struck me a lot and I decided to bring a couple of them to Italy.

In Rome, beginning in 1965, we studied its properties. I then had a visit from Ugo, son of Edoardo, my fellow soldier during the military service. Ugo had come to know, from his Father, about the channeltrons and he had the idea of using them to perform experiments with a few Kev atomic electrons, along the lines of experiments at much higher energy.

We performed for the first time the experiment (e,2e) with great success, thus giving beginning of a new branch of atomic physics [1]. Experiments of this kind are today

[1] Since then I abhor reading an instruction manual. Self-taught, I was the first one (PhD thesis 1962, the University of Iowa with J.A Van Allen) to have used computers for analyzing large amount of data.

performed in various laboratories around the world[2].

In Italy, these experiments were continued, using the same apparatus, at the INFN in Frascati under the direction of Anna Giardini.

After 1964, in January 1965, I began my activity as Amaldi's assistant. I was also in charge of teaching Space Physics. I was meeting Edoardo only to discuss student problems and of course I was part of exam commissions. I also substituted for him in teaching when he was otherwise busy, about one time out of four. I also directed the implementation of an experiment for the measurement of the solar wind with the first ESRO satellite on elliptical orbit and I was also full with international commitments in the nascent field of space research.

In short, I was very burdened and, in my opinion, I did not have a suitable position. So I told Amaldi that I would go away, leaving my position as assistant.

## 3 A fruitful interlude

I then returned to the University of Iowa with a research contract obtained negotiating directly with van Allen (who had offered me in the past a position as professor).

The year 1969 was a very fruitful year, because I deepened my knowledge of the van Allen belts. I realized that the van Allen belts could be a powerful source of cosmic rays and I managed to get a formula that expresses quite well the energy spectrum of the cosmic rays[3].

I published this result with a letter in the journal Nature after discussing it with van Allen (I also wrote some experimental and theoretical papers on trapped radiation).

Finally, during this period, I developed the idea, which I have always had in in my mind, that I wanted to deal with a fundamental physics problem. I decided that I would devote myself to the experimental search of gravitational waves.

We returned to Italy with Claudia, our fourth daughter, ten months old.

## 4 New Life

### 4.1 First Phase

The first thing I did, on September 3 1970, was to tell Edoardo Amaldi: *Professor, I've decided to do an experiment to search for gravitational waves.*

He looked at me with his deep and inquiring gaze[4] and the decision was made [2].

[2] In 1996, in Australia, a PhD student working on a (e,2e) experiment asked me for my autograph in his laboratory notebook.

[3] I have verified in 2018, making use of the Italian PAMELA satellite, that the magnetospheres can be sources of cosmic rays. I have found that Jupiter contributes to the measured flux of cosmic rays on Earth for a few percent, with an error of about ten standard deviations.

[4] Edoardo Amaldi had always thought to experimenting in the field of General Relativity. He informed me that also Massimo Cerdonio was thinking to make an experiment on gravitational waves. Therefore, immediately, I went to see Cerdonio and he showed me he had collected the Weber's papers. I learned that in the past Amaldi had also contacted Giorgio Ghigo.

Neither of us mentioned how, a year ago, I had run away.

Not even on purpose, just a week later, I learned that a commission chaired by Giuseppe Occhialini, had judged me first in a competition for the chair of physics at the University of Lecce[5].

I formed a research group by choosing the best of my past collaborators in space physics. To the meetings with the whole group also Nicola Cabibbo often attended.

The technique to use for our research, resonant bar or interferometer laser, I decided after Remo Ruffini sent us Stanford's proposal for one large aluminum bar cooled with liquid helium. We decided to establish a collaboration of our group with the Universities of Stanford and Louisiana.

My direct interaction with Edoardo during the four years I partly spent at Lecce consisted of our Saturday morning meetings, at the Amaldi house, where we studied the physics of gravitational waves.

A position as full professor at the University of Rome became available. The assembly of the Physics Department in Rome decided that the chair should have been assigned to me.

On Saturday, at the Amaldi house, when it was time for me to leave, I told Amaldi: *...good, so we can work together more easily.* He stared at me and said, *It won't be like this...*my surprise *why? the institute voted for me...*but he shook his head.

I learned later that Amaldi had decided to assign the chair to Giorgio Fiocco, a geophysicist[6].

I immediately telephoned Occhialini but, before I could make an action with no return, the geophysicist Enrico Medi died at the age of 63, thus making available another chair.

I was called to the Physics chair then available. When in 1978 Edoardo Amaldi went out of role, thus leaving his own chair, he asked me if I wanted to change mine to Space Physics or to General Physics (the one he left). I said: General Physics and I think he was happy.

### 4.2 The house by the sea

In Rome my relations with Edoardo Amaldi intensified. In the summer of 1975 he invited me to his house by the sea and we worked for a week. Ginestra, Edoardo's wife, was also there and occasionally some grandchildren. It was the first time that Edoardo Amaldi entered full time in the problem of gravitational waves.

I had already been at the Amaldi house by the sea in the autumn of 1962, when I found myself, just returned from America, acting as secretary for a meeting of the Pontif-

[5]This is because I had carried out an experiment on the solar wind, with the first European satellite with an eccentric orbit. Occhialini thought I would continue to devote myself to space research.

[6]I don't know if Amaldi's decision was due to his will to support geophysics or rather to political pressure. In any case, this fact shows that he has put his personal interests in the background.

ical Academy of Sciences which was dealing with the problem of space physics, the new frontier of knowledge.

From 1975 it became a habit to go to lunch by the sea, at the Amaldi house, once in August. I went together with Elena, who I had been lucky to marry and who gave me strength and serenity for my work. Elena established a good relationship with Ginestra. This habit continued even in the year following Edoardo's death. When Elena and I, in August 1990, went to the sea for tea in the afternoon, Ginestra wanted us to come back on another day for lunch, because she wanted us to continue as in the past

### 4.3 Close Collaboration

In the laboratories engaged in our experiment (SNAM Progetti, Istituto di Fisica, Frascati CNR and finally CERN[7] ) we made measurements and produced results.

The papers, after discussion in the group, were written by Edoardo and me. The two of us argued, then he wrote with a pen. The text was given to the secretary Pellizzoni who typed it. After another session of ours, Edoardo made the corrections on the typed text, which was retyped. So on, for three four times until the final version. The secretary told me, after Edoardo's death, that Edoardo had kept all the various copies.

Every morning, around 10:30, we went to the bar for a coffee, sometimes with Pallottino. Edoardo always paid. Once only Pallottino and I went, because it seemed to us that he was busy. He was sorry we didn't ask him.

During these coffee breaks, once he told me that I was the physicist he had collaborated the longest, another time he told me he didn't know who to vote for in the political elections, another time he told me about the experiments with Enrico Fermi and he said to me: *it really didn't occur to us that we had broken the atom. We thought that with the radioactive elements we produced we could help medicine.*

I must add a comment: Not even Enrico Fermi, one of the greatest physicist of all time, had enough **imagination!**

We also went on trips together for conferences. Once, returning, he no longer found the car he parked at the Fiumicino airport. They had taken it away because, during the week, they had changed parking permits. I accompanied Edoardo to pick up the car where the police had taken it. He told me he could have the fine canceled, but he wouldn't do it.

[7]The idea of conducting our activity at CERN came to me in September 1977. Our initial attempt to carry out the experiment at SNAM Progetti had failed, when the industry withdrew from the project. A reasonable place to work would have been at the INFN laboratories in Frascati. But, at that time, it was practically impossible to do this, cause of political instability. So, I thought a great place would be CERN, to which the INFN had close ties.

When I proposed this to Amaldi (without having consulted with my collaborators) he pointed out to me that we would run the risk of being engulfed by such a large research center. To his observations I replied that, if this had happened, it would have been good for the experiment itself.

We had a first meeting with the director of the CERN L.Van Hove on November 22, 1977, and another one on March 6, 1979. An agreement was signed of Amaldi and Pizzella with CERN.

CERN would contribute buildings, cryogenic liquids and technical support. A CERN physicist, Giorgio Cavallari, would cooperated with our group.

Edoardo often came to CERN and I picked him up at the airport. He wanted to contribute the experimental work, and he was saying: *I can also help just by handing over the screwdriver.*

Once Edoardo came with William Fairbanks and hosted Fairbanks and me in the Ugo empty house in Geneva.

The last time he came to CERN, I accompanied him, as usual, to the airport. Arriving about ten meters from the parking lot, the engine of the car stopped and, in neutral gear, I managed to get to the parking lot smoothly. I had to call a mechanic to accommodate and pick up the car after a few hours.

The last convivial meeting of the group was in a restaurant in Trastevere about mid-November 1989, near the "Accademia dei Lincei", of which he was the President. He arrived five minutes late, which was not his habit. He said that he had problems with parking. I told him: *but how... is a parking lot in the academy.* Edoardo: *I didn't want to disturb the guardian.*

The last time I saw Edoardo Amaldi was on the morning of December 1st 1989.

## 5 Edoardo Amaldi Conferences on Gravitational Waves

The first Conference of this series was held in Frascati in the Villa Tuscolana on 14-17 June 1994. Eds. E.Coccia, G.Pizzella, F.Ronga [4]. The name to the conference was suggested by Eugenio Coccia. The second Conference was held at CERN on 1-4 July 1997. Eds. E.Coccia, G. Pizzella, G. Veneziano [5].

The conferences take place every two years and are the: **premier forum for the fields of gravitational waves science and gravitational waves detection**.

In the twelfth conference LIGO announced the discovery of gravitational waves[8].

One might wonder why the name of Edoardo, who has not discovered the gravitational waves[9], has been assigned to this important lecture series on gravitational waves.

In my opinion this is right and I will explain, below, why Edoardo Amaldi, who already before my proposal in 1970 was thinking about General Relativity experiments and specifically on gravitational waves [10], has brought a contribution, perhaps decisive, to their discovery.

### 5.1 Scenario on the experiments for the research of the gravitational waves, particularly in the U.S.A

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[8]For this discovery the Nobel Prize was awarded to Kip Thorne, Barry Barish and Rainer Weiss.

[9]At the end of the nineties our group had realized two cryogenic antennas, EXPLORER and NAUTILUS, which were the most sensitive in the world, fig.1. In particular, we had carried out an absolute calibration of the antennas (unique among the gravitational wave detectors in preparation), by measuring, under the guidance of Francesco Ronga, their response to cosmic rays.

[10]see:
https://www.youtube.com/watch?v=sGjkxQF4ckQ

In 1972, at a Conference in Cambridge (USA), Joseph Weber shows an amplifier which, he says, allowed him to obtain the discovery of gravitational waves. Robert Forward, a former student of Weber, plays a tape with noise made by one of its laser interferometers. A whistle is heard and he says it might be the sound of gravitational waves.

William Fairbank talks about his project for a magnetically suspended 5-ton bar. He says he could have had results within two years. I speak of the collaboration that we has just begun with Fairbank and I say that we could have had results within five years.

Weber's experiment is repeated by various groups: IBM, Bell Tel/Rochester, Frascati/Munich, Moscow, Meudon, Glasgow, Reading, Tokyo. All these groups DO NOT confirm Weber's findings and end their search.

On October 17, 1989, due to the California earthquake that damaged their antenna, the group in Stanford decides to end their own experiment.

In this scenario Louisiana would not have been able to operate their antenna (without our help). In fact, the magnetic suspension never worked and, in the end, they used our suspension. Also their transducer was copied from ours.

At this point, 1989, the search for gravitational waves is in the following state:

- there are no resonant detectors in operation.
- Weber has been severely criticized and even accused of having altered his data.
- As for interferometers, there had been studies at MIT with a 1-meter interferometer and in Germany with a 3-meter one.
- In 1981, a simple 40-meter interferometer was built at Caltech for study the feasibility of the experiment with interferometers over long distances.
- For LIGO, requests for funding were always refused until 1991, when Congress approved 23 million in funding for the first year; however, the standards for receiving the funds were not met and NSF questioned the project's technological and organizational soundness.
- Project management issues and technical concerns, highlighted by NSF, led to a funding freeze in 1993.

In 1994, Barry Barish was appointed as project director, and NSF reported that the LIGO project had the last chance to be funded.

A new financial plan and a new executive project were presented fore an investment of 385 million, higher than the previous one. This new proposal was approved by NSF, and in 1994 the LIGO project became the largest and most expensive NSF-funded project.

### 5.2 Considerations

One wonders how it is possible that in the USA, in a very competitive climate for financing, a large loan has been granted to LIGO, in a situation where Weber was banned, the

attempts in the USA with the bars failed, and there were also theoretical doubts about the physical existence of gravitational waves.

I believe plausible to think about the possibility that funding for LIGO has received a first boost after Isaacson's visit to CERN in 1982, fig.2, and later after my letter to Senator Mikulski, fig.3. To this letter the Senator replied on November 5, 1991, fig.4, writing she had recommended support for LIGO at the required level. For this I received a thank you from LIGO, fig.5.

The letters were written by me, thinking about Edoardo Amaldi. I had one very solid foundation, CERN.

As shown in fig.6, in 1989 our group at CERN was the strongest in the world for the search of gravitational waves.

In my opinion, the important fact was the **CERN entry into the gravitational wave field. It must be stressed that Edoardo Amaldi was one of the CERN founders. The participation of CERN to the gravitational wave experiments has given greater credibility to this research, creating an international competitive atmosphere, and thus making a decisive contribution to the realization of LIGO and subsequent detection of gravitational waves.**

I enclose the letter from Reinar Weiss, fig.7, acknowledging our contribution to the discovery.

## References


[1] *Use of a two channeltron coincidence in a new line of research in atomic physics*
U. Amaldi, Jr., A. Egidi, R. Marconero, G. Pizzella
Rev. Sci. Instr. 40 1001 (1969).

[2] *Search For Gravitational Waves*
E. Amaldi and G. Pizzella
In *Pantaleo, M, De Finis, F.:
Relativity, Quanta, and Cosmology, Vol.1, 9-139
Johnson Reprint Corporation, 1979

[3] First Edoardo Amaldi Conference on gravitational wave experiments
Villa Tuscolana, Frascati, 14-17 June 1994.
Ed. Coccia, G.Pizzella, F.Ronga.

[4] Second Edoardo Amaldi Conference on gravitational wave experiments
CERN 1-4 July 1997.
Ed. E.Coccia, G. Pizzella, G. Veneziano.


Figure 1: NAUTILUS, the most sensitive detector for gravitational waves at the end of the nineties. In the open Museum of the Frascati National Laboratory of INFN.

NATIONAL SCIENCE FOUNDATION
WASHINGTON D C 20550

September 3, 1982

Professor Guido Pizzella
G23-Istituto di Fisica dell'Universita
Piazzale Aldo Moro, 2
Roma 00185
Italy

Dear Professor Pizzella:

I would like to take this opportunity to express my gratitude for your hospitality and kindness in showing me the Italian gravitational research facilities in Rome, Frascatti, and Geneva. Although this was my first visit, of course I have closely followed the progress of your group as reported at conferences and in the literature. Nevertheless, I was still enormously impressed with the research already under way in Rome, as well as with the potential of the new installation at CERN.

As you know, my responsibilities at NSF require me to be aware of current trends and new developments in gravitational physics. Consequently, I have had frequent opportunities to visit all of the U.S. experimental gravity facilities. The Italian bar-receiver development program compares very favorably with the state-of-the-art here! In size, your group seems to have about as many people as the extire U.S. bar-detector effort (which is spread across Stanford, LSU, Maryland and Rochester). The quality of your general purpose laboratory equipment, computers, and electronics seemed at least as good as what I have seen in the U.S.. I found your group particularly impressive in involvement with significant technological developments likely to be crucial during the coming decade (D.C.- SQUIDS, cryogenics, parametric transducers, etc.) and for its solid engineering philosophy in the design of the overall system and its components.

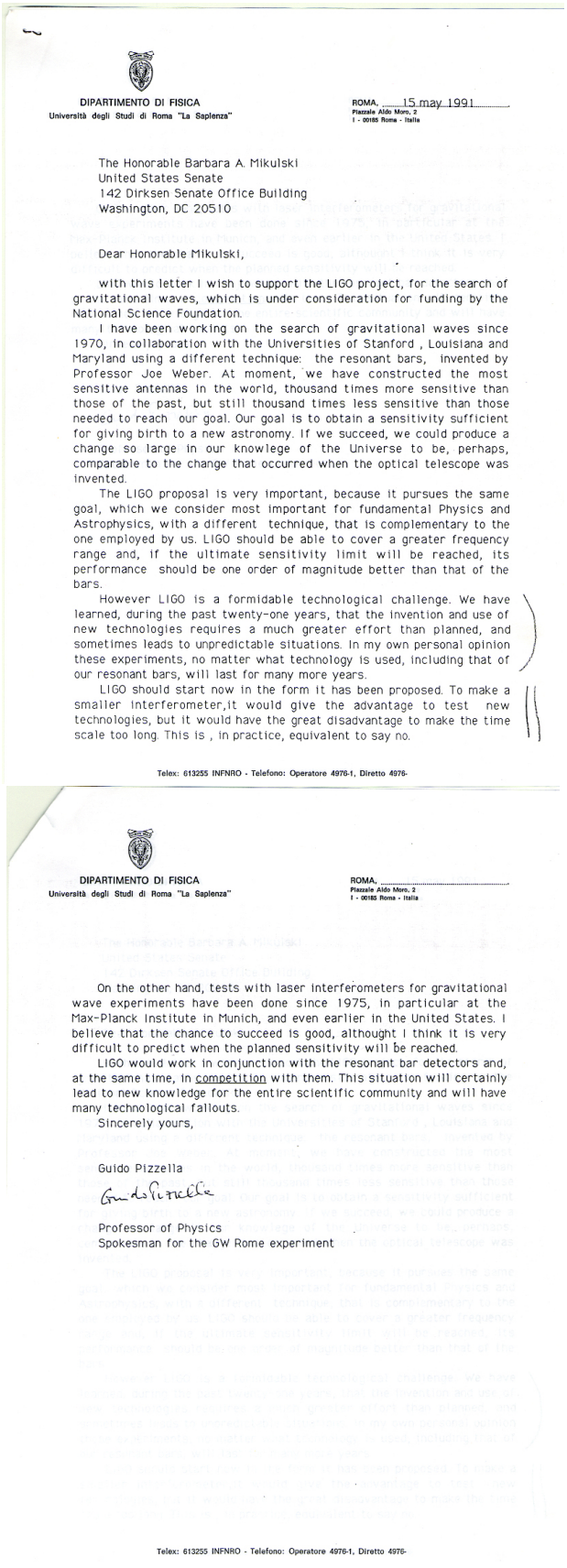
Based upon my visit, it seems clear to me that your low temperature bar-detector is likely to be among the very best resonant receivers in the world. I look forward to seeing it in operation soon, carrying out large baseline coincidence experiments with U.S. groups. If I can ever be of any assistance in bringing this about, please contact me and I will certainly work hard at helping out.

Best regards,

Richard Isaacson

Richard Isaacson

Figure 2: Letter by Isaacson



DIPARTIMENTO DI FISICA
Università degli Studi di Roma "La Sapienza"

ROMA, 15 may 1991
Piazzale Aldo Moro, 2
I - 00185 Roma - Italia

The Honorable Barbara A. Mikulski
United States Senate
142 Dirksen Senate Office Building
Washington, DC 20510

Dear Honorable Mikulski,

with this letter I wish to support the LIGO project, for the search of gravitational waves, which is under consideration for funding by the National Science Foundation.

I have been working on the search of gravitational waves since 1970, in collaboration with the Universities of Stanford , Louisiana and Maryland using a different technique: the resonant bars, invented by Professor Joe Weber. At moment, we have constructed the most sensitive antennas in the world, thousand times more sensitive than those of the past, but still thousand times less sensitive than those needed to reach our goal. Our goal is to obtain a sensitivity sufficient for giving birth to a new astronomy. If we succeed, we could produce a change so large in our knowlege of the Universe to be, perhaps, comparable to the change that occurred when the optical telescope was invented.

The LIGO proposal is very important, because it pursues the same goal, which we consider most important for fundamental Physics and Astrophysics, with a different technique, that is complementary to the one employed by us. LIGO should be able to cover a greater frequency range and, if the ultimate sensitivity limit will be reached, its performance should be one order of magnitude better than that of the bars.

However LIGO is a formidable technological challenge. We have learned, during the past twenty-one years, that the invention and use of new technologies requires a much greater effort than planned, and sometimes leads to unpredictable situations. In my own personal opinion these experiments, no matter what technology is used, including that of our resonant bars, will last for many more years.

LIGO should start now in the form it has been proposed. To make a smaller interferometer,it would give the advantage to test new technologies, but it would have the great disadvantage to make the time scale too long. This is , in practice, equivalent to say no.

Telex: 613255 INFNRO - Telefono: Operatore 4976-1, Diretto 4976-

DIPARTIMENTO DI FISICA
Università degli Studi di Roma "La Sapienza"

ROMA, .....
Piazzale Aldo Moro, 2
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On the other hand, tests with laser interferometers for gravitational wave experiments have been done since 1975, in particular at the Max-Planck Institute in Munich, and even earlier in the United States. I believe that the chance to succeed is good, althought I think it is very difficult to predict when the planned sensitivity will be reached.

LIGO would work in conjunction with the resonant bar detectors and, at the same time, in competition with them. This situation will certainly lead to new knowledge for the entire scientific community and will have many technological fallouts.

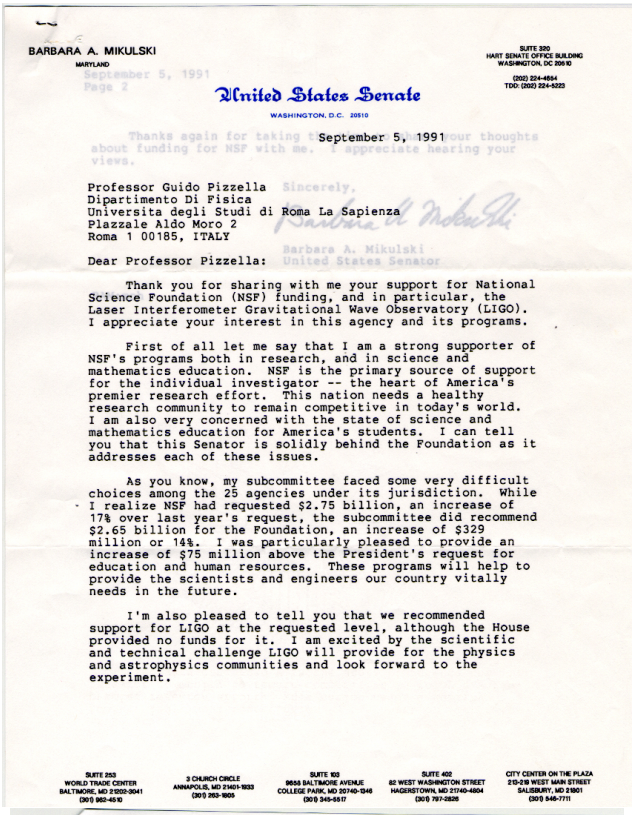
Sincerely yours,

Guido Pizzella

Professor of Physics
Spokesman for the GW Rome experiment

Telex: 613255 INFNRO - Telefono: Operatore 4976-1, Diretto 4976-

Figure 3: My letter to senator Mikulski



BARBARA A. MIKULSKI
MARYLAND

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United States Senate
WASHINGTON, D.C. 20510

September 5, 1991

Professor Guido Pizzella
Dipartimento Di Fisica
Universita degli Studi di Roma La Sapienza
Plazzale Aldo Moro 2
Roma 1 00185, ITALY

Dear Professor Pizzella:

Thank you for sharing with me your support for National Science Foundation (NSF) funding, and in particular, the Laser Interferometer Gravitational Wave Observatory (LIGO). I appreciate your interest in this agency and its programs.

First of all let me say that I am a strong supporter of NSF's programs both in research, and in science and mathematics education. NSF is the primary source of support for the individual investigator -- the heart of America's premier research effort. This nation needs a healthy research community to remain competitive in today's world. I am also very concerned with the state of science and mathematics education for America's students. I can tell you that this Senator is solidly behind the Foundation as it addresses each of these issues.

As you know, my subcommittee faced some very difficult choices among the 25 agencies under its jurisdiction. While I realize NSF had requested $2.75 billion, an increase of 17% over last year's request, the subcommittee did recommend $2.65 billion for the Foundation, an increase of $329 million or 14%. I was particularly pleased to provide an increase of $75 million above the President's request for education and human resources. These programs will help to provide the scientists and engineers our country vitally needs in the future.

I'm also pleased to tell you that we recommended support for LIGO at the requested level, although the House provided no funds for it. I am excited by the scientific and technical challenge LIGO will provide for the physics and astrophysics communities and look forward to the experiment.

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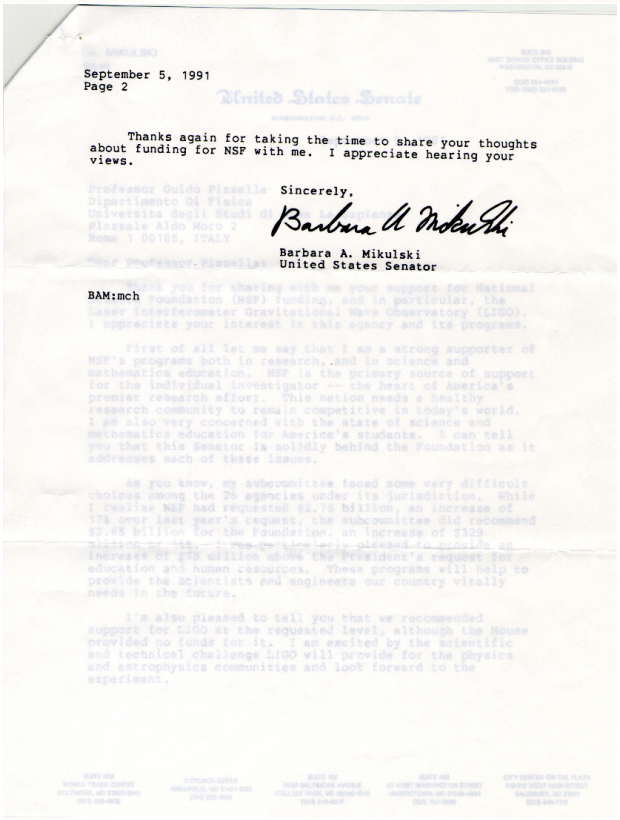
212-218 WEST MAIN STREET
SALISBURY, MD 21801
(301) 546-7711



September 5, 1991
Page 2

Thanks again for taking the time to share your thoughts about funding for NSF with me. I appreciate hearing your views.

Sincerely,

Barbara A. Mikulski
United States Senator

BAM:mch

Figure 4: Reply by senator Mikulski

**CALIFORNIA INSTITUTE OF TECHNOLOGY**

102-33 E. BRIDGE LABORATORY
PASADENA, CALIFORNIA 91125

LIGO PROJECT
Telephone (818) 356-2129
Fax (818) 304-9834

June 5, 1991

Dr. Guido Pizzella
Physics Department
University of Rome
Piazzale A. Moro, 2
1-00185 Rome
ITALY

Dear Dr. Pizzella:

We greatly appreciate the letters of support for the LIGO project that you wrote to Congress recently. The broad and strong support demonstrated by your letter and others has been a most important positive factor in our efforts to secure funding for this new venture.

We are facing an uphill fight in Congress this year, and the final decision on our level of support for 1992 will not be made for some months. Whatever the outcome this year, we will continue to need Congressional backing in the years to come, and your letters will be of continuing value in our interactions with Congress.

Sincerely,

Rochus Vogt
The R. Stanton Avery Distinguished
Service Professor and Professor of Physics
Director of the LIGO Project
California Institute of Technology

Stanley Whitcomb
Deputy Director of the LIGO Project
California Institute of Technology

Kip S. Thorne
The William R. Kenan, Jr., Professor
and Professor of Theoretical Physics
California Institute of Technology

Rainer Weiss
Professor of Physics
Massachusetts Institute of Technology

Figure 5: Thanking letter by LIGO

The Editors (Ashby, Bartlett and Wyss, 1989) of the 12th General Relativity and Gravitation wrote in the Preface of the Proceedings:

"We note with sadness that GR-12 was the last important conference for two of the significant figures in physics in the last half of the twentieth century: William M. Fairbank and Edoardo Amaldi. Ironically, they were raised in traditions far removed from general relativity but both had made important experimental contributions to the field during the past twenty years. Fairbank…started the cryogenic gravity wave detection project at Stanford to further advance the pioneering experiments of Weber. Amaldi joined with Pizzella…move the experimental laboratory to CERN where it has become *the world's strongest program*…They both expressed great confidence that a coordinated effort would lead us to the discovery of GW and the development of GW

Figure 6: $12^th$ General Relativity and Gravitation 1989.

**From:** Rai Weiss
**Subject:** **Re: congratulations !**
**Date:** March 2, 2016 5:30:05 PM GMT+01:00
**To:** Pizzella <guido.pizzella@Inf.infn.it>

Guido,
Thank you for the note. Now we know what the resonant bars should have been designed for - much lower frequencies.
A lot was learned from your experiments that has been applied to VIRGO and LIGO.
RW

On Wed, 17 Feb 2016, Pizzella wrote:

> Rainer
> may I congratulate you on your remarkable achievement !
> Best wishes
> Guido Pizzella

Figure 7: Letter by Reimar Weiss

Figure 8: Left: Ginestra ed Elena. Right: Edoardo Amaldi and Guido Pizzella at a 1984 Relativity Conference in Padova. Photo shotted by Emilio Segré.