

## Beppo Occhialini in Brazil between Physics and Politics

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*Abstract:* The aim of this work is to offer an analysis of the documents kept in Italian and Brazilian archives on Occhialini's activity in Brazil in the late 1930s. Occhialini went to São Paulo to help Gleb Wataghin in creating a new Physics team. Due to Brazil's geomagnetic location and the scarcity of funds, they chose cosmic ray physics as the main subject of research. We shall analyze Occhialini's main activities of research and his contribution to the international conference on cosmic rays held in Rio de Janeiro. As for the political context of the time, we shall show Occhialini's activity in helping people living under European regimes, in particular the role he played in the Houtermans affair.

*Keywords:* Occhialini, São Paulo, Cosmic ray physics, Houtermans.

### 1. Introduction

Giuseppe “Beppo” Occhialini's scientific biography has been considered by current historiography (Russo 1996) (Bignami 2002), (Gariboldi Tucci 2006), in particular as for his most relevant contributions to cosmic ray physics: 1) his collaboration with Patrick Blackett which led to the invention of the controlled cloud chamber; with this device they could take photographs of the creation tracks of an electron-antielectron pair by annihilation of a gamma ray; 2) his collaboration with Cecil Powell in the development of nuclear emulsions which led to the first photographs of the decay tracks of a pion into a meson (today: muon). Historiographical analyses of Occhialini's other researches are less detailed. In this paper, we shall analyze the archival documents held in Milan (BIFC Library, University of Milan) and São Paulo (Department of Physics, University of São Paulo) concerning Occhialini's activity in Brazil during the second half of the 1930s (Gariboldi 2006) (Ribeiro de Andrade 2006).

### 2. Occhialini in Brazil

After having spent three years at the Cavendish Laboratory in Cambridge, where he had worked in Patrick Blackett's team, Occhialini went back to Arcetri (Florence). Researches in cosmic ray physics in Arcetri had been already interrupted since all mem-

bers of the team led by Bruno Rossi had moved to other universities. From 1934 to 1937 Occhialini fulfilled his military duties at the Military School in Lucca. He then taught physics at the Royal Institute of Arts and at the Faculty of Architecture in Florence. In 1937 he was appointed to the scientific high school in Macerata but he never assumed the assignment since he left Italy for Brazil.

Two factors favored Occhialini's departure for Brazil. On one hand, the University of São Paulo needed to appoint professors. The University had been established a few years earlier, in 1934, supported by São Paulo bourgeoisie which wanted to rival the capital, Rio de Janeiro. Since there was not a sufficient number of university professors in Brazil, the University of São Paulo called some professors from Europe. In order to avoid an unwanted politic influx, the university made a distinction by nationality: Italian professors were assumed to teach scientific subjects, while French or Belgian professors to teach humanities. On the other hand, the Fascist government wanted to act on the cultural policy of a country like Brazil with a consistent minority of Italian origin. Enrico Fermi had already travelled to Brazil for a scientific collaboration in 1934 (Caruso, Marques 2014) (Silva 2015).

Occhialini accepted an invitation by Gleb Wataghin, a Ukrainian-born Italian physicist who was at the University of São Paulo on Fermi's suggestion. Occhialini joined him to rise a new school of cosmic ray physics to be studied with counters and cloud chambers. Occhialini was salaried by the Italian government in the context of the Fascist political-cultural action in Brazil. Occhialini's activity in São Paulo had to stop in March 1942 when Brazil declared war on Italy and he became an enemy alien. The Italian government called him back to his homeland but he did not succeed in obtaining free transit, hampered by the British government. He therefore took refuge in the Itatiaia mountains, near São Paulo, where he worked as a mountain guide. In September 1943, Italy surrendered to the allied forces, including Brazil, and signed the armistice. Occhialini tried to return to Italy, but obstacles to free transit continued to act. In the meantime, he was hosted in the Carlos Chagas' biophysics laboratory in Rio de Janeiro. Eventually he was able to arrive in Europe, in England, only in early January 1945.

### **3. Occhialini's teaching in Brazil**

Occhialini was in charge of teaching General and Experimental Physics, while Wataghin was in charge of teaching Higher Physics (i.e. contemporary physics). In the 1941-42 academic year, Occhialini was also professor of Higher Physics. The teaching programs are kept in the archive in São Paulo. These programs have been thoroughly analyzed in (Tavares 2017). Occhialini and Wataghin offered a university teaching of European level that had the positive effect of creating a research team that could bring young Brazilian physicists into contact with the international scientific community. The archive in Milan keeps some papers by some of Occhialini's students; they most probably are reports concerning some topics he taught in Higher Physics.

#### 4. Occhialini's researches in Brazil

Occhialini's research activities mostly concerned cosmic ray physics. This branch of physics had been in full development on an international level for some twenty years and was particularly suited to a Brazilian team for several reasons. First of all, cosmic rays are a free source of elementary particles of different kinds, unlike expensive radioactive sources. In a situation of scarce funding for scientific research, this aspect was fundamental for several research teams, even in Italy. A second factor concerned the instrumentation to study cosmic radiation: they were devices at least in part of sufficiently simple and economical construction, for example the counting tubes which could be made in an average equipped university laboratory. Other devices, such as the cloud chamber, could require more experience to build and higher costs to generate the accessory magnetic fields. A third factor favorable to a Brazilian team was the geomagnetic location, making Brazil a place of interest for international cosmic ray measurement campaigns, such as those made by Arthur Compton, even during the war (Freire, Silva 2014).

In this context, Occhialini dealt with the following main research topics: 1) the ultra-soft component of cosmic radiation (Occhialini 1941), (Occhialini, Schönberg 1939a), (Occhialini, Schönberg 1939b), (Occhialini, Schönberg 1948); 2) the variation in latitude of the ultra-soft radiation (Occhialini 1939), (Occhialini 1940a), (Occhialini 1940b); 3) the variation in the intensity of cosmic rays during a solar eclipse (Monteux, Occhialini, Damy De Souza Santos 1948), (Occhialini, Damy de Souza Santos 1940). Other researches, we are not going to write about here, concerned improvements in existing instruments for the detection of cosmic rays.

The research activities are known above all from scientific publications in journals, especially the *Annals of the Brazilian Academy of Sciences*, and from the proceedings of the 1941 International Symposium on Cosmic Rays which featured Compton's leading role. The São Paulo archival documents do not allow an advancement of our knowledge of these researches while the Milan ones give some more sporadic information in the correspondence, some new elements – such as a draft of an article on mesons in the upper atmosphere that was never published, and the notes of a series of measures.

The first topic – the study of the ultra-soft component of cosmic rays at the Brazilian geomagnetic latitudes, was quite a novelty. In those years, the main interest was in the hard component, while in Italy Gilberto Bernardini and Bruno Ferretti had already been interested in the ultra-soft component. Occhialini's team was able to determine the isotropy of the ultra-soft component, mostly consisting of showers produced in the atmosphere and corresponding to 16% of the total radiation. These results were presented at the Rio de Janeiro symposium in 1941.

The second topic was the study of the variation in latitude of ultra-soft radiation. Occhialini made a campaign of measurements during his return trip to Italy, from Bahía to Trieste, and with the data collected three papers were published between 1939 and 1940. A convincing dependence on latitude was not observed, so they claimed that the showers were not affected by a latitude effect, somehow confirming their origin from

an initial uncharged ray, such as a gamma ray. Another campaign of measurements, aboard the *Neptunia*, was unsuccessful because a violent change in electrical voltage damaged the high voltage filter making the counters unusable. The third topic – the effect on the intensity of cosmic rays of a solar eclipse – was studied thanks to the solar eclipse observed by São Paulo on October 1st 1940. The more general aim was to see if solar phenomena, by acting on the Earth's magnetic field, could be partly shielded from the Moon and more particularly affect the intensity of cosmic rays. The data obtained with different instruments required, due to their large quantity, a long time to be fully analyzed and led to an estimated 20% increase in the intensity of cosmic rays and were presented at the Rio de Janeiro symposium in 1941. The measurements were repeated during the eclipse on March 27th 1941 leading to an increase of only 1% in intensity. Some hints on the measurements of the first eclipse can be identified in Occhialini's correspondence and highlight a lack of clarity on the arrangement of the devices and on the fact that the eclipse was annular with a non-optimal shadow cone. The original data and the graphs of the second eclipse are instead kept among the archive documentation.

The archive in Milan allowed us to corroborate with new information the little knowledge we had about a couple of Occhialini's journeys to Manchester in 1938-39. Some information about his stay in England was provided by Occhialini in an interview in 1971 where he mentioned that he had built a cloud chamber to take to Brazil. As for the first travel to Manchester, thanks to the correspondence with Blackett, we can say that Occhialini arrived in Manchester between the 12th and a few days before the 28th of March 1938, while we do not know when he left. The second journey must have taken place after November 22th 1938. In a letter written on November 11th 1938, Blackett wrote him that the machined casting of a cloud chamber was waiting for him. From clues contained in a 1941 diary and from a letter written by Jánossy to Occhialini on January 26th 1940, we can believe that this cloud machine was actually built and taken to Brazil probably in the first months of 1939.

## **5. Occhialini in the totalitarian political context**

Eventually, we here consider a subject concerning Occhialini during the years in Brazil in relation to some personalities touched in a different way by the political activity of various European totalitarian regimes. The most interesting case is the Fritz Houtermans's one. The biography of Houtermans has already been treated in (Khrplovich 1992), (Frenkel 1997), (Amaldi 1998), (Belloni 2000), (Belloni 2001), and (Landrock 2003). Houtermans was a German-Jewish physicist trained in Göttingen, sympathetic to Communism. In 1933 he moved with his wife Charlotte to Cambridge where they became friends with Occhialini. They were there joined by Sasha Leipunski from Kharkov who convinced him to move to the Kharkov Institute of Physics, despite Pauli's attempts to dissuade him. However, they observed that the Institute was always under the control of armed guards, and from 1937 some colleagues began to be arrested. In 1937 his wife Charlotte left the USSR, officially for a vacation, with her daughter, and tried to persuade some of his former colleagues in England to invite her husband abroad. Nobody believed

her. Meanwhile, suspicions grew in Kharkov and she had to return to Kharkov. They moved to Moscow to Landau's house. On December 1st 1937 Houtermans was arrested and imprisoned in Lubianka. Thanks to Niels Bohr's help, Charlotte managed to travel to Denmark, then to London and the USA. Together with Bohr, she tried to help the scientists arrested in the USSR. Thanks to Eleanor Roosevelt's intervention on the ambassador in Moscow, she was able to find out that Houtermans was still alive. Irène Curie, Frédéric Joliot and Jean Perrin sent a telegram and a letter to Stalin in June 1938 asking for the release of, among others, Houtermans. The political situation saw – in succession – the Austrian Anschluss (March 1938), the Sudeten meeting in Munich (September 1938), the Molotov-von Ribbentrop non-aggression pact (August 1939), the German-Soviet partition of Poland. Following the Molotov-von Ribbentrop pact, German Communists who had emigrated to the USSR were handed over to the Gestapo. Houtermans was thus imprisoned in Berlin in 1940 and later released in July 1940. Thanks to archival documentation, we can describe the role played by Occhialini in the attempt to free Houtermans from the USSR. In a letter dated April 8th 1938, Houtermans's wife wrote that she was terribly glad that Joliot answered so quickly to his request. She hoped that Joliot would go on either writing to Bohr or just doing everything himself. She stated she had such a feeling as if Occhialini's project might work. In a second letter, dated July 1st 1938, Houtermans's wife wrote him that at last Joliot's letter had gone off and would have been presented by the French ambassador in Moscow. She wrote again that she was very grateful to him Peppino for having talked to Joliot. In this very letter, his wife described Houtermans's conditions in captivity, not in solitary confinement. In a third letter, dated July 25th 1938, Houtermans's wife wrote asking him to write again to Joliot, just asking to let him know, when there will be an answer, or perhaps what Joliot intended to do in case there would have been no answer. From these three letters we can fully appreciate Occhialini's role in the genesis of the letter sent to Stalin to ask for Houtermans's freedom. Other few letters concern Occhialini and three other scientists who asked about the possibility of leaving Europe for Brazil or the United States. Gerhard Herzog, a Swiss physicist, on April 29th 1938 asked Occhialini for information on living conditions in Brazil, due to the continually worsening European political situation. He emigrated to the United States in 1938.

Leo Pincherle, a physicist at the University of Padua, a former student of Fermi, wrote to Occhialini on August 9th 1938, shortly before the enactment of the first racial laws. He wrote him that he wanted to go abroad and he would preferably have come to São Paulo, but also possibly to some other university in Brazil (and also in other South American states), as a professor of physics, or, a little less willingly, also of algebra, calculus or mechanics. Pincherle lost his teaching position at the University of Padua and was forced to emigrate. He then moved to Switzerland and eventually to England, where he became a professor at Bedford College of the University of London. Guido Pontecorvo, Bruno's brother, a biologist, in a letter dated February 17th 1938 wrote to Occhialini that some rather urgent reasons were pushing him to find a decent accommodation. He therefore would have sent him a detailed curriculum to São Paulo along with his publications. Lastly, in the Brazilian years Occhialini continued his correspondence with Kate Margaret Thornycroft who at that time helped several Spanish refugee children in Eng-

land after the end of the Spanish War and was active in sending money and instructions to help people in German-occupied Czechoslovakia to escape to Poland.

These documents let us understand that Occhialini, even from Brazil, was an important player in those difficult times in helping scientists living in harsh or degenerating conditions in some European countries with a totalitarian regime.

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