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Rudolf Mössbauer and the development of the Garching research site

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Abstract The scientific career of Rudolf Mössbauer is intricately interwoven with the development of the Garching research site and the present day Garching campus of the Technical University of Munich. A brief description of this development will be given.

Keywords Rudolf Mössbauer · Garching · Technical University of Munich

1 The early days

In 1956 the construction of the first research reactor in Germany began. The reactor, a commercial swimming pool reactor made by the US company AMF, became critical on October 30, 1957, at a time when Mössbauer had already discovered recoilless nuclear gamma resonance, but had not yet published his results. The reactor was built in a remote area about 10 miles north of the city of Munich, on the diluvial gravel plain west of the river Isar, and about 2 miles from the nearest settlement, a small village named Garching. At that time nobody would have predicted the stupendous development this patch of land was to undergo in the 50 years to come. Figure 1 shows the reactor site in about 1960. The egg-shaped building houses the reactor, and the barracks next to it is where the handful of researchers worked. The scientific director of the reactor was Professor Heinz Maier-Leibnitz, the PhD supervisor of Rudolf Mössbauer at the Technical University of Munich (TUM).

The construction of the Garching reactor and the discovery of the Mössbauer effect roughly coincide in time, but on Maier-Leibnitz's recommendation Mössbauer performed the experiments which resulted in the discovery of recoilless nuclear gamma resonance absorption at the Max Planck Institute of Medical Research in Heidelberg, where the experimental conditions were by far superior to those

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Fig. 1 The site of the Garching research reactor (the egg-shaped building) in about 1960. Mössbauer had set up his laboratory in the left of the two low barracks facing the reactor

at Maier-Leibnitz's crowded Munich institute. The radioactive ^{191}Os sources Mössbauer needed for his experiments with the 129 keV transition in ^{191}Ir were produced at Harwell, England, and—according to what Mössbauer told occasionally—carried to Heidelberg in his suitcase. Mössbauer published his results in 1958 [1, 2], and only after that did he construct a Mössbauer spectrometer in one of the barracks next to the Garching reactor. This spectrometer [3] was about a meter high and 2 m long and consisted of two cryostats cooled with liquid hydrogen, one for the source and the other for the absbsorber. The absorber cryostat sat on a trolly running on rails and moving back and forth by about 20 cm, driven by a chain running over sprocket wheels. The cryostats were designed by Werner Wiedemann, a collaborator of Walter Meissner and expert in low temperature techniques. It was first used to study the broad 134 keV resonance in ^{187}Re [3]. In fact, Mössbauer was not the only researcher working in Mössbauer spectroscopy in Munich and at Garching in the early days. Others were, to name just a few, Egbert Kankeleit, who developed the double-loudspeaker type velocity drive, Mike Kalvius, who studied the 8.4 KeV resonance in ^{169}Tm and Paul Kienle, who became interested mainly in nuclear physics aspects of the Mössbauer method. The author started doing a diploma thesis under Mössbauer's supervision in the fall of 1960, but Mössbauer left soon afterwards for the United States, having accepted an offer to work at the California Institute of Technology (Caltech, Pasadena). He was awarded the Nobel Prize for his discovery of recoilless nuclear resonance absorption in 1961, when he was already working at Caltech. Notwithstanding, after his departure a lively Mössbauer group remained active at Garching, mainly under the supervision of Paul Kienle and, as far as his limited time permitted, Maier-Leibnitz himself. In the course of time a number of new buildings were erected at the Garching site, for instance the administrative building for the reactor shown in the left middle of Fig. 2, which shows the place in about 1965. Not all of the building activity was for the Technical University, though. For instance, the newly founded Max-Planck-Institute for Plasma Physics was established just south of the reactor site.

Fig. 2 The reactor site in about 1965. On his return to Munich, Mössbauer had his office in the right front corner of the two-storey administrative building at the left margin of the picture and his laboratories were in the two flat barracks from the early days of the reactor. The radiochemistry laboratory needed to make Mössbauer sources was in the ring-shaped building surrounding the reactor

2 The second Mössbauer effect

For the Garching site, a major step forward was taken in 1964, when Mössbauer agreed to return from the United States to become full professor at the Technical University of Munich. In his negotiations with the Bavarian State Government he was in a rather strong position. One of the conditions for his return was the that a proposal made several years earlier by the physics professors of TUM for the foundation of a big physics faculty with many new positions for physics professors and scientific and other staff be finally accepted by politics and that a big new building was to be built at the Garching site. Mössbauer got what he asked for, and this miracle of sorts became known as "The Second Mössbauer Effect". In the United States Mössbauer had seen the department system with a many professors on an equal footing, and this was to become the structure for the new institute, which was duly called the Physics Department.

Figure 2 shows the Garching site at about the time of Mössbauer's return. He moved into an office in the recently added administrative building and had his laboratories in the two flat barracks, in one of which he had set up his first Garching spectrometer 5 years previously. Mössbauer brought Richard Cohen to Munich, who had done his PhD thesis with him at Caltec. Richard helped him to set up his research group. The Mössbauer spectroscopy group that had been working at Garching during Mössbauer's absence continued under the direction of Paul Kienle. In fact, the two groups worked side by side in the same laboratories rather peacefully, except for some occasional mutual accusations of pinching equipment, which was always a bottleneck in our research efforts. Meanwhile, the new Physics Department building was being constructed (Fig. 3) north of the reactor site and during the years 1969 and

Fig. 3 The Garching research campus in about 2005, with the now sizeable town of Garching behind, the city of Munich in the rear and the Alps in the haze on the horizon. The new high flux reactor, officially called the Heinz Maier-Leibnitz neutron source, is the big building left of the egg-shaped building of the 1957 Garching research reactor. The building of the Physics Department is in the foreground next to the two reactors

1970 everybody moved into it, including most of those who had still been working on the city campus of the Technical University.

The Garching campus continued to grow. Chemistry was the first faculty after physics to move from downtown Munich to Garching. Eventually, the faculties of mechanical engineering, and of mathematics and computer science followed. Several more Max Planck institutes—for extraterrestrial physics, for astrophysics and for quantum optics—as well as the European Southern Observatory are now situated on the Garching research site. In the late 1960s a tandem Van de Graaff accelerator was built jointly by the Technical University and the Ludwig Maximilian University of Munich, and, last but not least and after considerable political squabble, the new high flux research reactor of the Technical University became operational in 2005, five years after the old 1957 reactor whose construction had laid the foundation of the Garching research site had been closed down in the summer of 2000. A present day view of the Garching campus is shown in Fig. 3. The startling development of the Garching research campus is certainly not all due to Rudolf Mössbauer, but the Nobel Prize laureate of 1961 certainly contributed much to what the Garching Campus is today.

In 1971 Mössbauer was offered the directorship of the Institute Laue-Langevin in Genoble, France, the high flux reactor that had been built in the late 1960s. To run his research group in Munich during his absence, Mike Kalvius came back from Argonne National Laboratory and became full professor at the Physics Department. Paul Kienle lost his interest in Mössbauer spectroscopy and eventually all Mössbauer spectroscopy work concentrated in the Klavius group.

Fig. 4 Rudolf Mössbauer and his friend Vitalii Goldanskii at a party in Fritz Parak's house during one of the joint Russian-German seminars

Fig. 5 Yuri Kagan, the Russian theoretician, and Rudolf Mössbauer in Fritz Parak's garden during the same joint Russian-German seminar

3 Mössbauer turns to neutrino physics

In the three decades to come, Mössbauer spectroscopy continued to flourish at Garching. In fact, the scope of hyperfine interaction studies was expanded by additional methods like time differential perturbed $\gamma - \gamma$ angular correlations (TDPAC) and muon spin resonance (μSR). Mössbauer himself, however, had largely lost his interest in nuclear gamma resonance when he returned from Grenoble to Munich in 1976. In Grenoble he had seen a group of researchers from Munich do experiments at the high flux reactor to study neutrino oscillations, and this field had fascinated him so much that he turned his interest to neutrino physics, mainly to neutrino oscillations. Some aspects of nuclear gamma resonance, however, continued to interest him, mainly the Bragg scattering of resonant gamma radiation from ideal crystals and the phase problem in x-ray structure determination of biological materials. The actual work in these fields was mainly done by Uwe van Bürck, who later became engaged in experiments with synchrotron radiation, and Fritz Parak, who eventually turned to biological applications of Mössbauer spectroscopy like the dynamics proteins. Mössbauer showed continued interest in these fields and gave support to them. Mössbauer also continued to support the collaboration with

physicists from countries behind the Iron Curtain, mainly the Soviet Union, which he had initiated already on his return from the United States. This collaboration largely sprang from his personal friendship with Vitalii Goldanskii of the Soviet (later Russian) Academy of Sciences. The lively exchange of scientists and a number of joint seminars held alternatingly in Germany and Russia was certainly a major feat during the years of the Cold War. To achieve this both Mössbauer and Goldanskii had to use all the influence on politics they could muster. Mössbauer used to enjoy this collaboration and the joint seminars, and also the parties going along with the latter. Figures 4 and 5 show him during a party held in Fritz Parak's home during one of these seminars. Mössbauer also still attended ICAME conferences, like the one at Garmisch in 1999, where he gave a talk on the discovery of the "M-effect", as he used to call it [4], or the one in Muscat, Oman in 2003. Mössbauer was not always happy with the development that the Physics Department eventually took, but his contribution to its foundation will always be remembered.

The eventual slow decline of Mössbauer spectroscopy at Garching began in the 1990s, when the Physics Faculty decided to put all its efforts into neutron physics and the use of the new high-flux research reactor and thus to eventually phase out the application of hyperfine methods in solid state science by not replacing researchers who either left or retired. The neutrino side of Mössbauer's activites, however, continues to flourish, now being part of the larger field of astroparticle physics. After his retirement in 1997, Franz von Feilitzsch became his successor and the group now is engaged in many experiments in neutrino physics and dark matter studies and is part of a larger research initiative for studying the origin and structure of the universe.

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