

## **LLR (Lunar Laser Ranging) in the Physical Institute of the USSR Academy of Sciences**

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The first experiments in Lunar Laser Ranging (LLR) were made at the McDonald Observatory in 1962-1963. In 1962 N.G. Basov, director of the Lebedev Physical Institute (FIAN), gave an order to start LLR. The first results were obtained in 1963 with the use of a ruby laser with a millisecond pulse length. This allowed to measure the distance to the Moon with the accuracy of 150-300 km, which significantly exceeded possible errors of other methods.

In 1965 a new Q-switched laser with a pulse length of the order of a hundred millionth of a second was installed. In 1966 it was used to determine the distance to the Flammarion (lunar crater) with the accuracy of 200 m.

In 1969-1973 five retroreflector packages were landed on the lunar surface: Apollo 11, Apollo 14 and Apollo 15 (USA) and Lunokhod-1 and Lunokhod-2 (USSR-France) which enabled to improve the accuracy of lunar ranging up to a few meters. In 1969 the program of lunar ranging was started at the McDonald Observatory. Due to joint efforts of FIAN and Crimean Astrophysical Observatory, LLR observations with a 2.6 m telescope were launched in Nauchny in the same year. In 1973 they obtained the first results of laser ranging with the accuracy of individual measurement of 0.9 m. Better accuracy (25 cm) was achieved after installation of a new laser in 1978. During the decade 1973-1983 this team obtained 1400 individual estimates of distance to the Moon (predominantly with the use of Apollo-15 and Lunokhod-2).

In 1983 LLR experiments in Nauchny have been discontinued. In 1984 we started LLR observations with a 1m telescope in Katziveli but no stable results have been achieved. In 2015 we plan to resume laser ranging observations of all five retroreflectors on the Moon with new equipment installed at the Crimean Laser Observatory (Katziveli).