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Studies of the LPM and TSF effects at CERN

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In 1953, Landau and Pomeranchuk showed [1] that multiple scattering of ultrarelativistic electrons on atoms of the medium can lead to suppression of bremsstrahlung in the soft part of the spectrum compared to the predictions of the Bethe-Heitler theory. A quantitative theory of this effect was later developed by Migdal [2]. The region of the radiation spectrum in which Landau-Pomeranchuk-Migdal (LPM) appears rapidly increases with increasing particle energy and in the region of TeV electron energies and above significantly affects almost the entire radiation spectrum, leading to a significant reduction in radiation losses of particles. As a result, such an important quantity as the radiation length begins to depend on the particle energy, which must be considered when designing particle detectors and radiation shielding at future high-energy lepton colliders. For this reason, at the end of the last century, a special experimental study of this E-146 effect was carried out at the SLAC accelerator to test the predictions of the Migdal theory of the LPM effect and the subsequent inclusion of this effect in computer codes such as GEANT and others [3]. However, when analyzing the experimental data obtained, it turned out that both the Migdal theory and the Bethe-Heitler theory do not fully describe the behavior of the emission spectra. Particularly significant discrepancies were observed for relatively thin targets [3]. Including into consideration the dielectric mechanism of radiation suppression (the Ter-Mikaelian effect [4]) and transition radiation did not eliminate the indicated discrepancy. The special behavior of the emission spectra in the case of a thin target was predicted earlier in [5, 6]. A quantitative theory of the effect of radiation suppression in a thin layer of substance was developed in [7] and are described in detail in the review [8]. A detailed experimental study of the discussed effects, with special attention to radiation in a thin target, was carried out by the NA63 collaboration in the 2000s at the CERN SPS accelerator [9]. After quantitative confirmation of theoretical predictions [7], the effect of radiation suppression in a thin layer of substance was called the Ternovskii-Shul'ga-Fomin effect or TSF effect [9]. Despite the fact that both LPM and TSF effects are caused by the influence of multiple scattering on the radiation process, their manifestations in the spectral and angular distributions of radiation, as well as in the thickness dependence of the radiation intensity, are radically different [6-10]. All these features of the bremsstrahlung process at high energies, when LPM and TSF effects begin to play a decisive role in the formation of bremsstrahlung, must be considered when designing future lepton colliders and detection systems for them. Analogues of the LPM and TSF effects should also take place in QCD during the interaction of quarks and gluons.

[1] Landau L.D. and Pomeranchuk I.Ya. Dokl. Akad. Nauk SSSR 92 (1953) 535, 735.
[2] Migdal A.B. Phys. Rev. 103 (1956) 1811.
[3] CERN Courier 34 (1994) #1; Klein S., Rev. Mod. Phys. 71 (1999) 1501.
[4] Ter-Mikaelian M.L., Dokl. Akad. Nauk SSSR 94 (1954) 1033.
[5] Ternovskii F.F., Sov. Phys. JETP 12 (1961) 123.
[6] Shul'ga N.F. and Fomin S.P., JETP Lett. 27 (1978) 117; Phys. Lett. A 114 (1986) 148.
[8] Akhiezer A.I., Shul'ga N.F. and Fomin S.P. Landau-Pomeranchuk-Migdal Effect. Cambridge Scientific Publishers, 2005, 215 p.
[9] Thomsen H.D. et al., Phys. Lett. B 672 (2009) 323; Phys. Rev. D 81 (2010) 052003.
[10] Fomin A.S., Fomin S.P. and Shul'ga N.F., Nuovo Cimento 34C (2011) 45.

Author: Dr FOMIN, Sergii (NSC KIPT)

Co-authors: Prof. SHUL'GA, Mykola (NSC KIPT); Prof. UGGERHOJ, Ulrik (Aarhus University)

Presenter: Dr FOMIN, Sergii (NSC KIPT)

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