K_L-K_S REGENERATION AT HIGH ENERGIES

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The phenomenon of regeneration consists of a transformation of an incident long-lived neutral K_L wave into a linear superposition of short- and long-lived states, K_S and K_L. It is expected to occur for any process in which K_0 and $\overline{K_0}$ interact differently. In particular, the amplitude for K_S regeneration from nuclei at momentum transfer q, is the half difference between the K_0 and $\overline{K_0}$ nuclear scattering amplitudes $\frac{1}{2}\{f(q^2) - \bar{f}(q^2)\}$. This process is coherent in the very forward direction (transmission regeneration). Both modulus and phase of $f(0) - \bar{f}(0)$ can be deduced from the observation of the interference between the regenerated K_S and the transmitted K_L waves.

We have measured the K_S intensity observing their decays into $\pi^+\pi^-$ mode after lead regenerators of various thicknesses exposed in a neutral beam derived from the high-energy extracted proton beam of the CERN Proton Synchrotron. The detector [1] and the experimental method [2] have been described in previous publications to which we refer for details. Transmission regeneration is identified by the characteristic sharp peak observed in the forward direction. We have also measured the q^2 dependence of the differential nuclear regeneration cross-section up to momentum transfers of 0.16 GeV/c, far beyond the first diffraction minimum. Results are presented in Fig. 1. They are compared to the predictions of calculations made in the framework of an optical model. The proton and neutron nuclear densities are described with Fermi distributions of the form $\{1 + \exp[(r-R)/d]\}^{-1}$. Imaginary parts of the kaon-nucleon amplitudes are determined from measured total cross-sections of charged kaons on nucleons (optical theorem and isospin symmetry) and real parts are deduced from the same total cross-sections with forward dispersion relations.

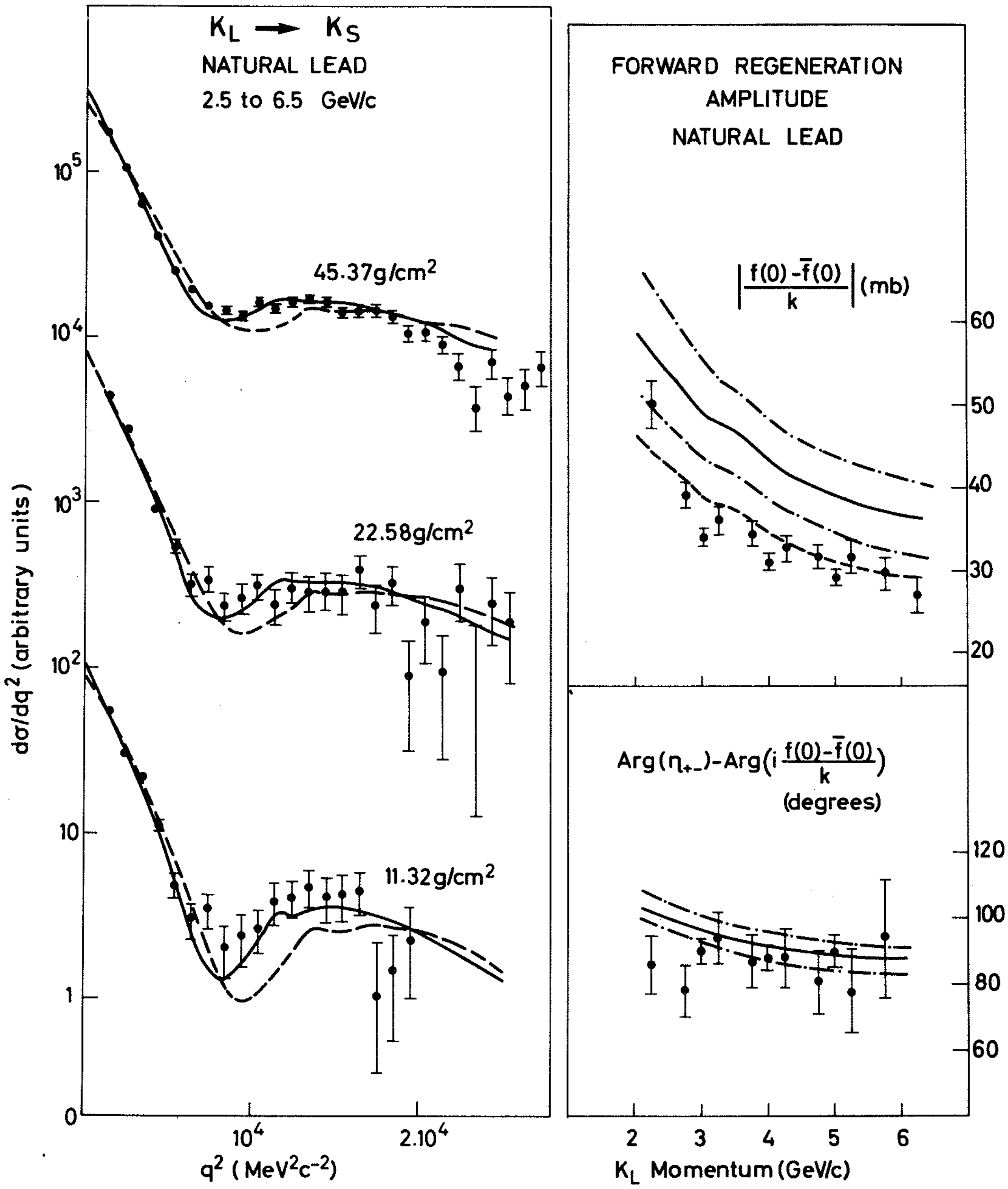
The q^2 dependence of the differential regeneration cross-section is modified by multiple scattering and by the presence of coherent regeneration along the path of the kaon before and after scattering. The effect results in a widening of the diffraction peak and in a filling of the minimum. It has been taken into account exactly.

The shape of the differential regeneration cross-section is not well reproduced when both proton and neutron distributions are taken equal to the nuclear charge distribution from electron scattering and muonic X-ray experiments [3]. It is relevant to remark that, since neutrons have a substantially stronger regeneration power than protons (by a factor 5 at 4 GeV/c) K_L-K_S regeneration is particularly sensitive to the neutron distribution inside the nucleus. Agreement can be achieved by increasing artificially the neutron radius R_n from 6.66 fm to 7.85 fm or the neutron surface thickness d_n from 0.50 fm to 1.02 fm. However, in both cases the predicted forward regeneration amplitude turns out somewhat larger than experimentally observed, but still within the uncertainties of the kaon-nucleon scattering amplitudes. The q^2 dependence of the differential regeneration cross-section is very sensitive to nuclear dimensions and practically unaffected by changes in the kaon-nucleon amplitudes. This sensitivity is enhanced by the opacity of the nucleus which causes regeneration to occur preferentially on its periphery.

Table 1

Parameters of the neutron distribution

Conditions	$d_n = d_p = 0.50$ fm $R_p = 6.66$ fm	$R_n = R_p = 6.66$ fm $d_p = 0.50$ fm
Fit to $\|f(0) - \bar{f}(0)\|$	$R_n = (6.6 \pm 0.6)$ fm	$d_n = (0.5 \pm 0.3)$ fm
Fit to $(d\sigma/dq^2)(q^2)$	$R_n = (7.85 \pm 0.12)$ fm	$d_n = (1.02 \pm 0.10)$ fm
Mean value	$R_n = (7.65 \pm 0.12)$ fm	$d_n = (0.86 \pm 0.10)$ fm



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