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Production of ⊠(1020) meson in nucleus-nucleus collisions at the CERN SPS

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The ϕ meson is a resonance particle and the lightest particle with hidden strangeness, containing both s and $\bar{s}$ quarks. Strangeness enhancement is considered to be related to Quark-Gluon Plasma formation, making the ϕ meson a valuable probe due to its "double strangeness" in a partonic and zero net strangeness in a hadronic medium. Previous studies, such as EPJC 80 (2020) 199, demonstrated that the rapidity distribution widths for various particles produced in p+p and Pb+Pb collisions follow similar linear trends with increasing beam rapidity. Interestingly, while ϕ mesons from p+p collisions conform to this trend, those from Pb+Pb collisions exhibit a markedly faster increase, a phenomenon that remains unexplained. To explore this problem, we present the first-ever measurements of ϕ meson production in Ar+Sc collisions at three beam momenta: 150A, 75A, and 40A GeV/c, recently released as preliminary data by the NA61/SHINE collaboration. Utilizing the primary decay channel $\phi \rightarrow K^{+}K^{-}$, invariant mass analysis, and the tag-and-probe method, we provide detailed double differential (y, pT) spectra, rapidity distributions, and total yields. These results are compared to previous ϕ meson production measurements in p+p and Pb+Pb collisions by NA61/SHINE and NA49, respectively. Special emphasis is placed on the rapidity spectra widths, offering new insights into the puzzling behaviour observed in heavy-ion collisions. This study advances our understanding of strangeness enhancement and the dynamics of ϕ meson production in nuclear collisions.

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