Non-linearities and magnetic field dependencies of the dielectric constant of $BaO{\cdot}Al_2O_3{\cdot}SiO_2$

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At low temperatures glasses and other amorphous solids exhibit very similar thermal, acoustic, and dielectric properties. These are attributed to atoms or small groups of atoms which are able to tunnel between at least two equilibrium positions. In the standard tunneling model specific assumptions are made for the distribution of the parameters that characterize these - non-interacting - tunneling systems. The last years have seen increasing evidence that this picture of non-interacting tunneling systems is inacceptable at least at very low temperatures [1].

Recent measurements [2,3] of the dielectric properties of the glass $BaO{\cdot}Al_2O_3{\cdot}SiO_2$ showed a strong and unexpected influence of an external magnetic field that indicated collective phenomena among the tunneling systems. We have continued these measurements and can present now a surprisingly rich spectrum of magnetic field variations of the dielectric constant and the corresponding dielectric loss. Below about 150 mK dramatic oscillations emerge which sharpen with decreasing temperature and in addition depend strongly on the amplitude of the electric driving field of the capacitance bridge. The interpretation of the experimental results is still speculative. Presently, we cannot competely rule out a certain influence of the magnetic moments of Fe^{3+} impurities. On the other hand, we see some correlations between the magnetic field effects and the observed non-linearities that point towards a close entanglement of the actions of the electric AC field and the magnetic DC field. We actually regard this as a clue to the interpretation of these intriguing new phenomena in the low temperature properties of glasses.

[1] see e.g.: A.L. Burin, D. Natelson, D.D. Osheroff, and Yu. Kagan, in *Tunneling Systems in Amorphous and Crystalline Solids*, ed. P. Esquinazi (Springer, Heidelberg 1998)

[2] P. Strehlow, C. Enss, S. Hunklinger, Phys. Rev. Lett. **80**, 5361 (1998)

[3] P. Strehlow, M. Wohlfahrt, A.G.M. Jansen, R. Haueisen, G. Weiss, C. Enss, S. Hunklinger, Phys. Rev. Lett. **84**, 1938 (2000)