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A2 DUPLICITY: A COMPILATION OF THE AMOUNT OF DIPOLE STRUCTURE OBSERVED IN A2 MESON EXPERIMENTS*

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In an attempt to find a way to compare various experiments that have looked for splitting in the A2 meson, I have fit these experiments to a distribution of the form

$$\delta \text{ (dipole)} + (1-\delta) \text{ (Breit-Wigner)}.$$

The parameter δ, which I call the duplicity (a name that was suggested to me by Alan Krisch), measures the amount of dipole structure observed in an experiment. A δ greater than 1 means that the data show a dip greater than possible for a dipole smeared out by experimental resolution.

The procedure was first to find the best fit (highest likelihood) to the data for a dipole and also the best fit for a Breit-Wigner, in each case with a linear background under the resonance. (One experiment, the CERN A_2^0 experiment, required a quadratic background). Then with the resonance parameters fixed at their best-fit values, but with the background parameters free, a fit was made to the above form.

The fits were made with the same fitting routines and the same resonance shapes that were used in our π-82 experiment.[5] For some experiments the data were obtained by reading the values off of published graphs, a procedure that is subject to error. (This is especially true for the CERN A_2^0 experiment.)

Perhaps the best way of determining the number of standard deviations of preference an experiment has for one or the other of the models is to quote $S = \sqrt{\Delta(2 \ln L)}$, the square root of twice the difference in the logarithm of the likelihoods for the two fits. The sign of S is arbitrarily defined to be negative if the dipole fit is best. The quantities δ and S, as well as the resolution that I used in the calculations, are tabulated below, and the values of δ are plotted.

I feel that these numbers, δ and S, provide a better method of comparing the results of various experiments than other methods that have been used. In particular they are better than confidence intervals, which are so dependent upon the interval in which the fit was done.

However, these parameters have their drawbacks. The obvious limitation of this parametrization is that it singles out the dipole structure to test, a structure that has little theoretical justification and is chosen only because the missing mass spectrometer data were observed to fit it well. This parametrization is useless in looking for other types of structure.

A more subtle failing of this parametrization is that even though the dipole form has the same number of parameters as does the Breit-Wigner form, it nevertheless has more flexibility in fitting the data because the mass of the dipole can be adjusted to put the dip in the prediction where a dip happens to occur in the data. In an attempt to get a feeling of the magnitude of this effect, I generated 13 Monte Carlo experiments according to the best Breit-Wigner fit to the BDNPT data and analyzed each of these fake experiments by the method that I have used to analyze the real experiments. The result was that for 9 of the 13 random experiments the dipole fit better than did the Breit-Wigner! Four of the 13 experiments had $S < -2$ and one had $S = -2.7$, the value for the BDNPT experiment. Thus for a relatively low statistics experiment with a 1-to-1 signal-to-noise ratio such as the BDNPT experiment or Crenell et al., the natural bias of preferring a dipole is considerable and an S of -2.7 standard deviations is not as significant as it would be in a well-behaved system. This fact, coupled with the fact that many experiments that have looked at the A2 have not published their data, makes it difficult to estimate how many of the experiments with $|S|$ in the 2.5 to 3 level are significant.

Footnote and References

* Work done under the auspices of the U. S. Atomic Energy Commission.

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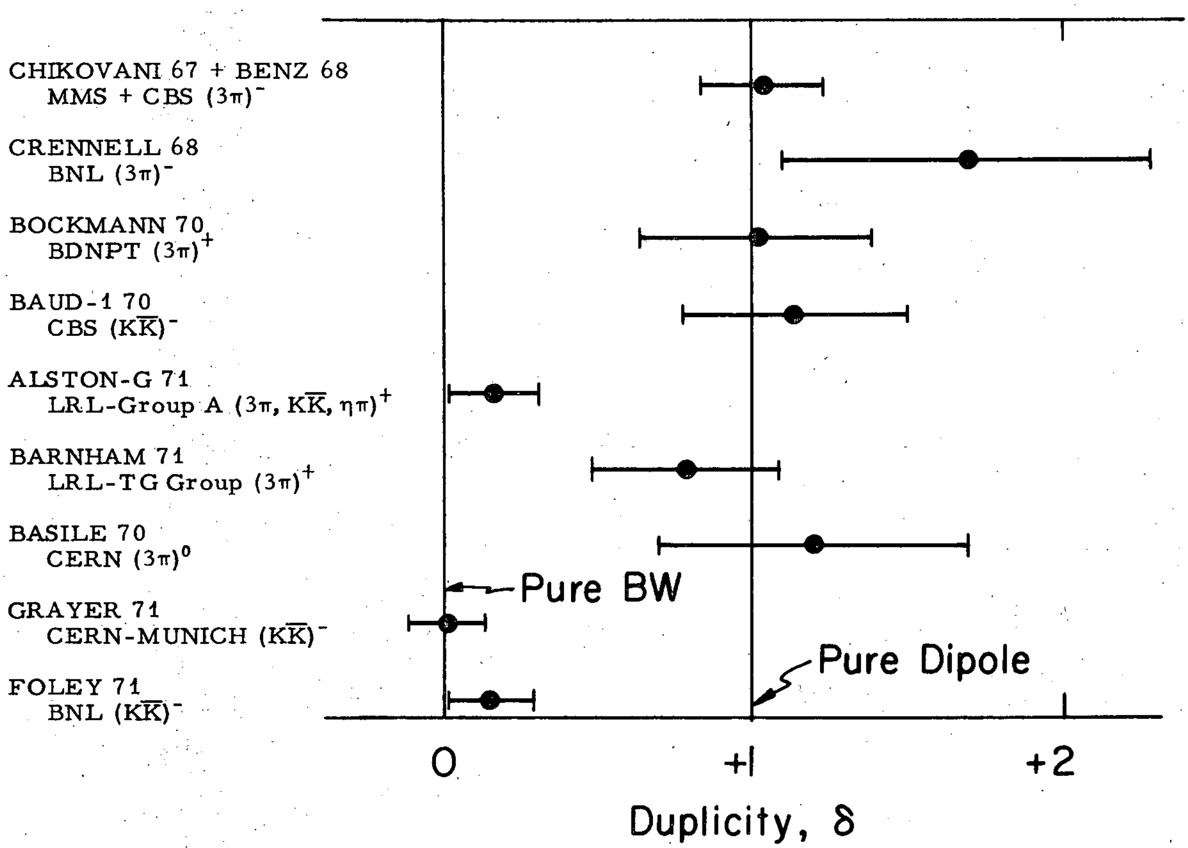
Experiment	Resolution $\Gamma/2$ (MeV)	Duplicity[a]	$S = \sqrt{\Delta(-2 \ln L)}$
1. MMS + CBS	5.9	1.04 ± 0.20	-6.1
2. BNL	5	1.7 ± 0.6	-2.9
3. BDNPT	5	1.02 ± 0.37	-2.7
4. CBS ($K\bar{K}$)	9.4	1.14 ± 0.36	-3.1
5. LRL-Group A	3.8, 6.7, 9.2	0.17 ± 0.15	5.7
6. LRL-TG Group	7	0.78 ± 0.31	-2.5
7. CERN A_2^0	9.4	1.2 ± 0.5	-2.8
8. CERN-Munich	5.9	0.01 ± 0.13	7.6
9. BNL ($K\bar{K}$)	5.5	0.15 ± 0.14	5.2

[a] Fit was to $dn/dm = \delta(\text{dipole}) + (1-\delta)(\text{Breit-Wigner}) + a + bm$.



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