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D'Alembert's Equation and the Binary Groups

D'Alembert's equation $f(xy) + f(xy^{-1}) = 2f(x)f(y)$ is solved over all finite groups. We introduce the notion of a *basic* D'Alembert function: one for which $f(xy) = f(x)$ for all x implies that $y = 1$. It is shown that every D'Alembert function factors through a basic D'Alembert function. Then we show that the only finite groups that support a basic D'Alembert function are the cyclic groups (the classical case) and the *binary groups*:

$$\langle 2, m, n \rangle := \langle R, S, T : R^2 = S^m = T^n = RST \rangle$$

in Coxeter's notation. Conversely each of these groups supports a non-classical D'Alembert function.