Variability in Blazars: Clues from PKS 2155-304

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Rapid variability on a time scale much faster than the light-crossing time of the central supermassive black hole has been seen in TeV emission from the blazar PKS 2155-304. The most plausible explanation of this puzzling observation is that the radiating fluid in the relativistic jet is divided into a large number of sub-regions which move in random directions with relativistic speeds. We consider two versions of this "jets in a jet" model. In the first, the "subjets" model, stationary regions in the mean jet frame emit relativistic subjets that produce the observed radiation. The variability time scale is determined by the size of the sub-regions in the mean jet frame. This model, which is motivated by magnetic reconnection, has great difficulty explaining the observations in PKS 2155-304. In the alternate "turbulence" model, various sub-regions move relativistically in random directions and the variability time scale is determined by the size of these regions in their own comoving frames. This model fits the data much more comfortably. We consider collisions between TeV photons emitted from different sub-regions and find that, in both the subjets and turbulence models, the mean bulk Lorentz factor of the jet needs to be greater than 25 to avoid the pair catastrophe.

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