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Statistical Outliers and Dragon-Kings as Bose-Condensed Droplets

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(Submitted on 7 May 2012)

A theory of exceptional extreme events, characterized by their abnormal sizes compared with the rest of the distribution, is presented. Such outliers, called "dragon-kings", have been reported in the distribution of financial drawdowns, city-size distributions (e.g., Paris in France and London in the UK), in material failure, epileptic seizure intensities, and other systems. Within our theory, the large outliers are interpreted as droplets of Bose-Einstein condensate: the appearance of outliers is a natural consequence of the occurrence of Bose-Einstein condensation controlled by the relative degree of attraction, or utility, of the largest entities. For large populations, Zipf's law is recovered (except for the dragon-king outliers). The theory thus provides a parsimonious description of the possible coexistence of a power law distribution of event sizes (Zipf's law) and dragon-king outliers.

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