Why large turbulence scales are the only contributors to jet noise

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It is shown that the radiation of jet noise is dominated by the contribution of large scale turbulent structures in the jet. The importance of the large scale motion in jets for their noise emission was anticipated in 1963 by Mollo-Christensen. These large scales are results of the inherent instability of the jet shear layers as shown by Michalke (1971). The peak frequency depends on the shear layer thickness, which explains why high frequencies are emitted from the region close to the nozzle, while low frequencies are emitted further downstream. The source field can be decomposed into contributions from axisymmetric and spinning components and it is shown that only a few components are present in the jet. In addition it is demonstrated that the radiation efficiency of higher order components is very small, which means that the near field close to the outer jet boundary and even more so the far field is dominated by only a few modes. This is true not only for the rear arc as claimed in recent papers but also for all other emission angles. It is shown how the directivity of jet noise is the result of source interference and wave refraction in the rear arc. It can be concluded that “fine scale turbulence” does not contribute to the far field noise of jets. The noise reduction caused by nozzle serrations (chevrons) is mainly achieved through a thickening of the shear layer, causing smaller growth rates of the instability waves. In addition, the serrations change the distribution of the sources into azimuthal components.