

FIG. 1 (color online). Shaded (normalized) isocontours of A_z in the (x, y) plane at $z = 0$, $t = 30$ in the asymmetric case. Minimum and maximum values are $\sim \pm 0.002$.

values are represented by the darker (lighter) regions, corresponding to a clockwise (counterclockwise) magnetic field. This figure clearly shows that the resulting magnetic field is characterized, in the asymmetric case, by a bubble-like shape with typical length scale of the order of a few d_e both in the perpendicular and in the parallel directions, i.e., by $k_{\parallel}^{-1} \sim k_{\perp}^{-1} \sim d_e$. On the other hand, in the symmetric case, the magnetic field structures are strongly anisotropic being elongated in the beams direction, i.e., $k_{\parallel}^{-1} \gg k_{\perp}^{-1} \sim d_e$. Similar results (not presented here) have been obtained, aside from the localization of the magnetic field around the resonance for two initially homogeneous beams.

We define the perpendicular and parallel averaged spectrum of A_z as the Fourier spectrum averaged along the z direction and in the (x, y) plane, respectively (and the same for the total density). As expected, in both cases the perpendicular spectra increase at $k_{\perp} < 1$ and reach a maximum at $k_{\perp} \sim 1$, corresponding to $\lambda \sim d_e$. At larger wave

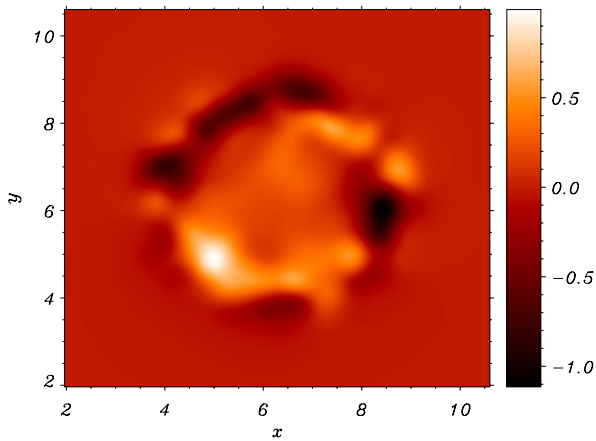


FIG. 2 (color online). Shaded (normalized) isocontours of A_z in the (x, y) plane at $z = 0$, $t = 25$ in the symmetric case. Minimum and maximum values are $\sim \pm 0.015$.

vectors, $k_{\perp} \geq 10$ the spectra decrease due to numerical dissipative effects of a filter, based on a fast-Fourier-transform algorithm, necessary for code stability [24]. Let us now discuss the longitudinal spectra which measure the characteristic length scale of the magnetic “filaments” in the beams’ direction. In Fig. 4, first two frames, we see that the A_z spectrum peaks are located at $k_{\parallel} \approx 0.8$ and at $k_{\parallel} = 0$ for the asymmetric and symmetric case, respectively. This corresponds to a characteristic length scale of the order of a few d_e in the asymmetric case, i.e., to a “bubblelike” magnetic structure, and to an “infinite” length scale, i.e., to very long magnetic filaments, in the symmetric case.

By comparing the asymmetric density spectrum, third frame, we observe the same peak at $k_{\parallel} \approx 0.8$, but with a spectrum decrease towards $k_{\parallel} = 0$. Moreover, in the symmetric case the density peak is not at $k_{\parallel} = 0$, as observed for A_z since at $k_{\parallel} = 0$ the TS contribution is lost and the mode becomes purely electromagnetic. Furthermore, the perpendicular density spectrum (not shown here), driven by nonlinear effects, is more than 2 order of magnitude smaller than the parallel one and rapidly decreases at $k_{\perp} < 1$. We therefore conclude that, in this regime, the density fluctuations are mainly driven by the TS contribution. However, density perturbations will strongly change their nature in the further regime when strong nonlinear effects and charge separation effects (induced by the self generated magnetic field) become important.

Our model of a relativistic beam propagating in a dense plasma shows that the Weibel instability generates bubble-like magnetic structures with typical parallel and perpendicular length scales of the order of a few d_e . This loss of

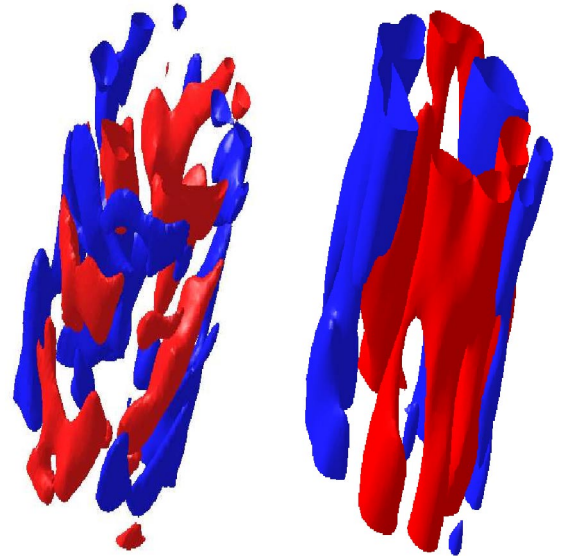


FIG. 3 (color online). Shaded isosurfaces of A_z at $t = 30$ and $t = 25$ in the asymmetric ($A_z \sim \pm 0.0009$) and symmetric ($A_z \sim \pm 0.008$) case, left and right frame, respectively.