Global structure of wake field behind a dielectric astrophysical object in the solar/stellar wind is studied by means of a 2.5-dimensional full electromagnetic Vlasov simulation. Interaction of a plasma flow with an unmagnetized or a weakly-magnetized object is quite different from that with a strongly magnetized object such as the Earth. Due to the absence of the global magnetosphere, the dielectric body absorbs plasma particles which reach the surface, generating a plasma cavity called wake on the anti-solar side of the object. For numerical simulations of electromagnetic structures around the wake, it is important to include both charging effect and ion cyclotron motion in global-scale simulations. It is confirmed that spatial structures of wake fields are affected by the direction of interplanetary magnetic field.