would be many bubbles or gluonic hot spots around the expanding surface. This led to a paper[5] which was our earlier version of Ref.[6]. In that paper we concluded that the behavior of the Hanbury-Brown and Twiss (HBT) measurements[4, 7] should be interpreted as evidence of a substructure of bubbles located on the surface of the final state fireball in the central rapidity region at kinetic freezeout. The HBT radii were decreasing almost linearly with transverse momentum and implying to us a source size of ∼2 fm radii bubbles were on the surface and could be selected for if we considered transverse momenta above 0.8 GeV/c. These momenta would allow sufficient resolution to resolve individual bubbles of ∼2 fm radii. We further concluded that these HBT quantum interference observations were likely due to phase space focusing of the bubbles pushed by the expanding fireball. Thus the HBT measurements of source size extrapolated to transverse momenta above 0.8 GeV/c were images of the bubbles. The HBT correlation has the property of focusing these images on top of each other for a ring of bubbles transverse to and centered on the beam forming an average HBT radius.

Thus our model was a ring of bubbles sitting on the freezeout surface with average size ∼2 fm radius perpendicular to the beam at mid-rapidity. The phase space focusing would also lead to angular correlations between particles emitted by the bubbles and be observable. Fig. 1 shows the geometry of the bubbles. For the background particles that account for particles in addition to the bubble particles we used unquenched HIJING[8] with its jets removed. We assumed that most of the jets were eliminated from the central events because of the strong jet quenching observed at RHIC[9]. We investigated the feasibility of using charged-particle-pair correlations as a function of angles which should be observable due to the phase space focusing of the particles coming from individual bubbles. At that point we fully expected that these correlations would be observable in the STAR detector[10] at RHIC if one analyzed central Au Au collisions. Correlation analyses are powerful tools in detecting substructures. Historically substructures have played an important role in advancing our understanding of strong (non perturbative) interactions. Our earlier paper explained the general characteristics of the angular correlation data, and was also consistent with HBT measurements in a qualitative manner. This motivated us to develop a reasonably quantitative model, the parton bubble model[6] which is discussed in the following.

II. PARTON BUBBLE MODEL[6]

In this publication[6] we developed a QCD inspired parton bubble model (PBM) for central (impact parameter near zero) high energy heavy ion collisions at RHIC. The PBM is based on a substructure consisting of a single ring of a dozen adjoining 2-fm-radius bubbles (gluonic hot spots) transverse to the collider beam direction, centered on the beam, and located at or near mid-rapidity. The at or near mid-rapidity refers to the boost invariant region that exist in the RHIC heavy ion collisions which spans 2-4 units of rapidity. Because of this spread in η, we will use the relative spread of particles in η ($\Delta\eta$) in order to capture the angular correlations along the beam axis. The ring resides on the fireball blast wave surface (see Fig. 1). We assumed these bubbles are likely the final state result of quark-gluon-plasma (QGP) formation since the energy densities produced experimentally are greater than those estimated as necessary for formation of a quark-gluon-plasma. Thus this is the geometry for the final state kinetic freezeout of the QGP bubbles on the surface of the expanding fireball treated in a blast wave model.

The average behavior of emitted final state particles coming from the surface bubbles at kinetic freezeout is given by the ring of twelve bubbles formed by energy density fluctuations near the surface of the expanding fireball of the blast wave. One should note that the blast wave surface is moving at its maximum velocity at freezeout (3c/4). For central events each of the twelve bubbles have 3-4 partons per bubble each at a fixed ϕ for a given bubble. This number of partons was determined from correlation data analyzed by the STAR experiment[6]. The transverse momentum (p_t) distribution of the charged particles is similar to pQCD but has a suppression at high p_t like the data.

The bubble ring radius of our model was estimated by blast wave, HBT and other general considerations to be approximately 8 fm. The bubbles emit correlated charged particles at final-state kinetic freezeout where we select a p_t range (0.8 GeV/c $< p_t <$ 4.0 GeV/c) in order to increase signal to background. The 0.8 GeV/c p_t cut increases the resolution to allow resolving individual bubbles which have a radius of ∼2 fm. This space momentum correlation of the blast wave provides us with a strong angular correlation signal. PYTHIA fragmentation functions[11] were used for the bubbles fragmentation that generate the final state particles emitted from the bubbles. A single parton using PYTHIA forms a jet with the parton having a fixed η and ϕ (see Fig. 2). The 3-4 partons in the bubble which shower using PYTHIA all have a different η value but all have the same ϕ