Photons from α clustered C+Au collisions at RHIC

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Heavy ion collisions at relativistic energies lead to the formation of Quark-Gluon Plasma, a deconfined state of quarks and gluons in local thermal equilibrium. Photons are emitted from each and every stage of the evolving system produced in such collisions and they are considered as one of the most efficient probes to study the initial hot and dense plasma state and its evolution [1].

It has been shown that the elliptic and triangular flow parameters of thermal photons show interesting nature as a function of transverse momentum which is significantly different from the p_T dependent nature of the anisotropic flow of hadrons [2]. The relative contributions of the photons produced from the QGP phase and the hot hadronic matter are considered to be responsible for this unique p_T dependent nature of the anisotropic flow. However, it has been found that the experimental photon v_n data underpredict the anisotropic flow from theoretical model calculations by a significant margin both at RHIC and at the LHC energies. The production and anisotropic flow of photons from deformed as well as from asymmetric collisions can be useful to understand this discrepancy between experimental data and results from theoretical model calculations.

Recent phenomenological studies suggest that the collision of α clustered carbon (^{12}C) with heavy nuclei can give rise to significantly large initial state eccentricities and consequently a large anisotropic flow of hadrons [3]. Electromagnetic radiations are more sensitive to the initial state compared to hadrons and thus expected to be a potential observable to study the clustered structure as well the anisotropic flow in such collisions.

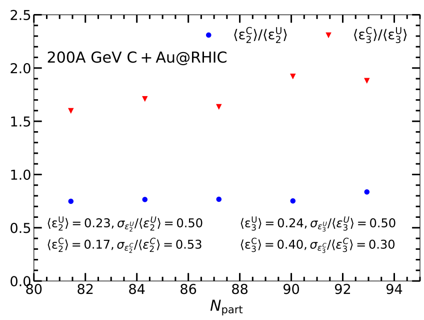

FIG. 1: The ratio of α clustered to unclustered initial state elliptic and triangular eccentricities from C+Au collisions at RHIC [5].

We study the production and anisotropic flow of photons from α clustered C+Au collisions at 200A GeV at RHIC and compare the results from unclustered C+Au collisions [4]. The results from most central collisions show that the photon spectrum varies only marginally from unclustered to clustered collisions. However, the anisotropic flow parameters are found to vary significantly for specific orientations of clustered C+Au collisions compared to the unclustered case. It is shown that angle $\theta = 0$ produces the highest multiplicity. It describes a situation where the symmetry axis is aligned with the beam axis

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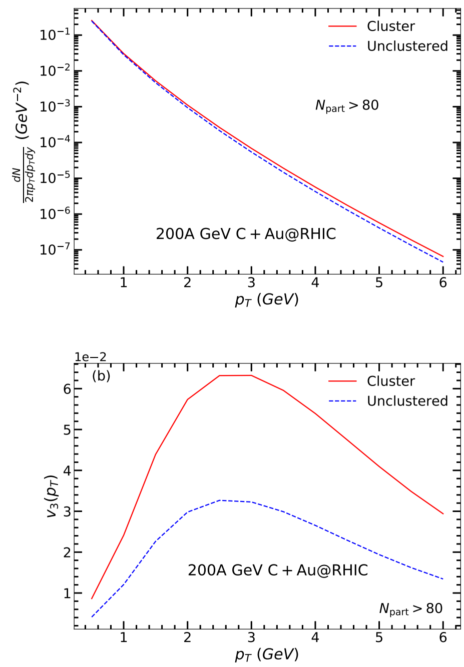

FIG. 2: [Upper panel] Thermal photon spectra and [lower panel] triangular flow parameter from α clustered C+Au and unclustered C+Au collisions at RHIC [5].

[see Ref [4] for detail]. Whereas, the orientation for $\theta = 90$ degree produces the minimum multiplicity.

The elliptic flow of thermal photons is found to be maximum for the angle $\theta = 90$ for a single event in most central clustered C+Au collisions. However, for the same orientation angle the triangular flow parameter is found to be minimum. The photon v_3 is found to be largest for $\theta = 0$ orientation. As expected, the elliptic flow parameter is found to be much smaller for this orientation angle.

Although these results show the potential of the clustered C+Au to study the photon anisotropic flow, an event-by-event estimation of the results would be more realistic when compared with the experimental data. In a recent study we estimate the photon production and anisotropic flow parameters from α clustered C+Au collisions at RHIC using an event-by-event hydrodynamical framework [5].

The event averaged ratio of initial eccentricity ϵ_2 and triangularity ϵ_3 from clustered and unclustered cases as a function of number of participants is shown in Fig. 1. The ratio of initial triangularity is found to be about 1.5 times larger than the initial eccentricity.

The photon spectra from clustered and unclustered cases do not show significant difference between them in event-by-event calculation [see upper panel of Fig. 2]. However, the event averaged triangular flow parameter is estimated to be significantly larger than the elliptic flow parameter even for most central collisions as shown in lower panel of Fig. 3. In addition, a prominent difference has been observed in the p_T dependent ratio of elliptic and triangular flow parameters (v_2/v_3) from collisions of clustered carbon compared to the unclustered case.

These results suggest that an experimental determination of photon spectra and anisotropic flow from collisions of carbon with heavy nuclei at relativistic energies may provide valuable information about the exotic α clustered structure of C nucleus. These may also be useful to know more about the initial state as well as photon anisotropic flow produced in relativistic nuclear collisions.

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