

## Electronic Supplementary Information (ESI)

### Understanding the Mechanism of Energy Transfer Process from Non-Plasmonic Fluorescence Bimetallic Nanoparticle to Plasmonic Gold Nanoparticle

Amit Akhuli,<sup>ab</sup> Naupada Preeyanka,<sup>ab</sup> Debabrata Chakraborty,<sup>ab</sup> and Moloy Sarkar<sup>ab\*</sup>

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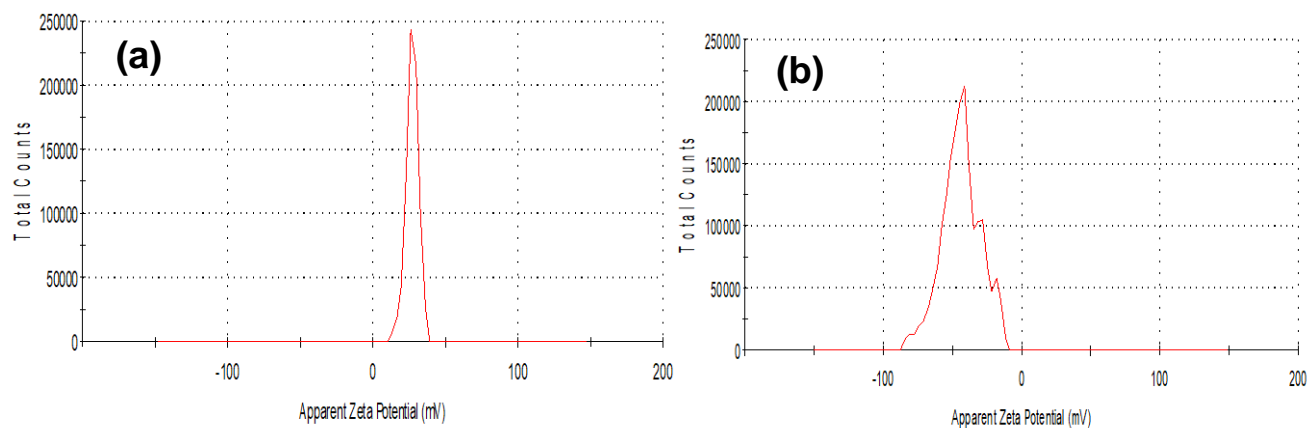
Amit Akhuli,<sup>ab</sup> Naupada Preeyanka,<sup>ab</sup> Debabrata Chakraborty,<sup>ab</sup> and Moloy Sarkar<sup>ab\*</sup>

<sup>a</sup>School of Chemical Sciences, National Institute of Science Education and Research (NISER),  
An OCC of Homi Bhabha National Institute, Jatni, Khurda, Bhubaneswar 752050, Odisha,  
India.

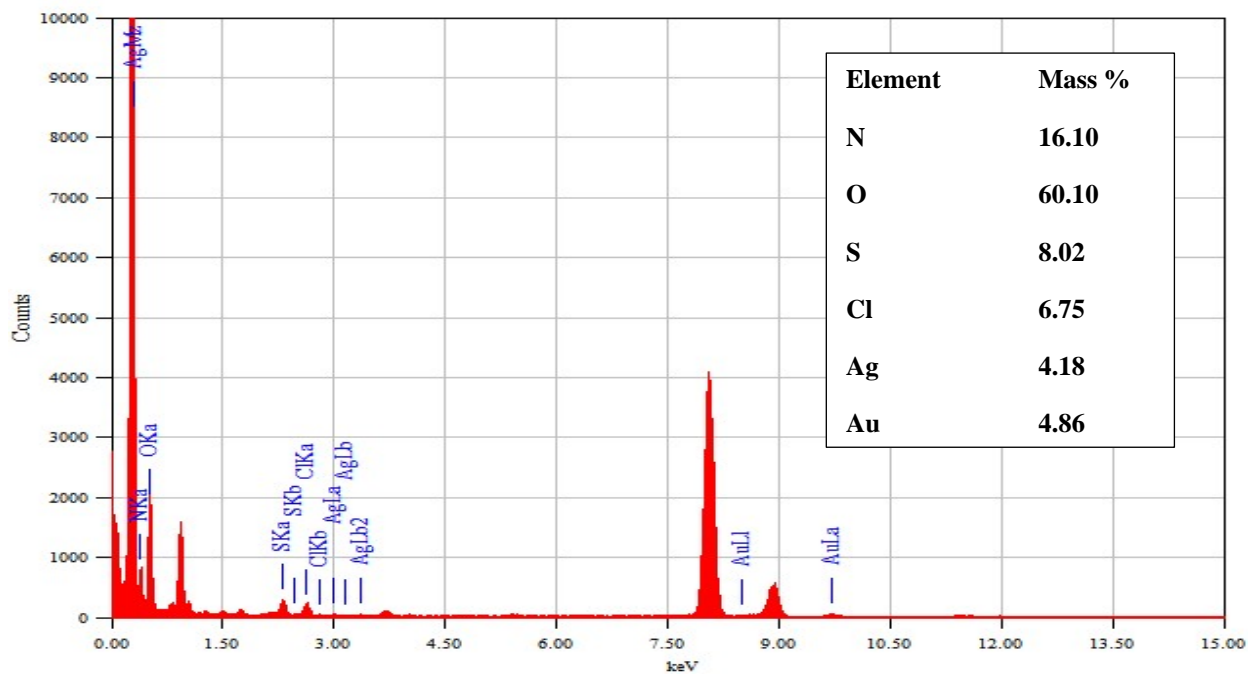
<sup>b</sup>Centre for Interdisciplinary Sciences (CIS), NISER, Jatni, Khurda, Bhubaneswar 752050,  
Odisha, India.

\*E-mail: [msarkar@niser.ac.in](mailto:msarkar@niser.ac.in)

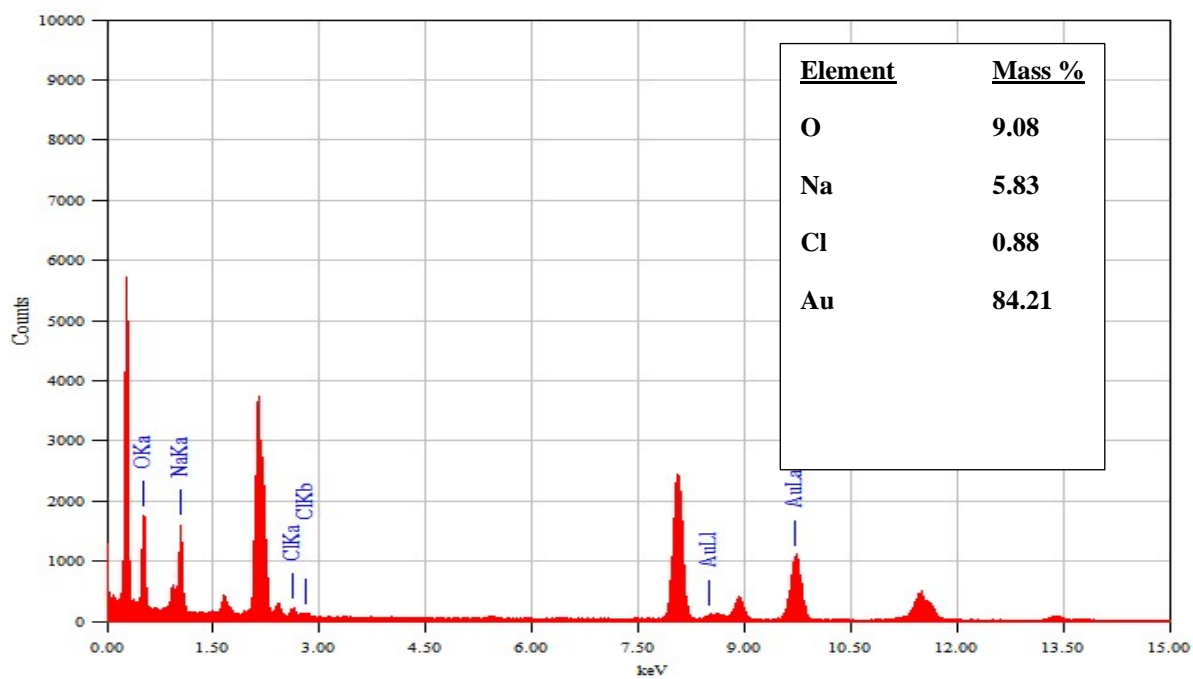
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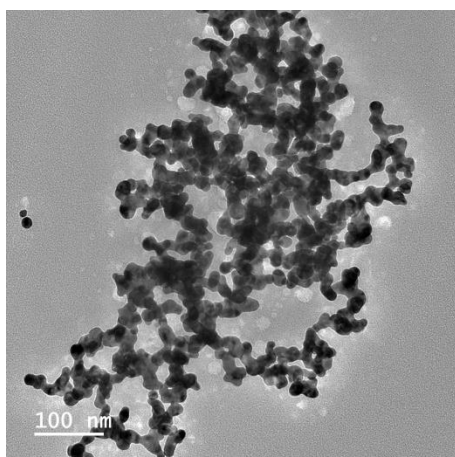
**Fig. S1** Zeta potential graph of (a) F-AgAu and (b) AuNPs



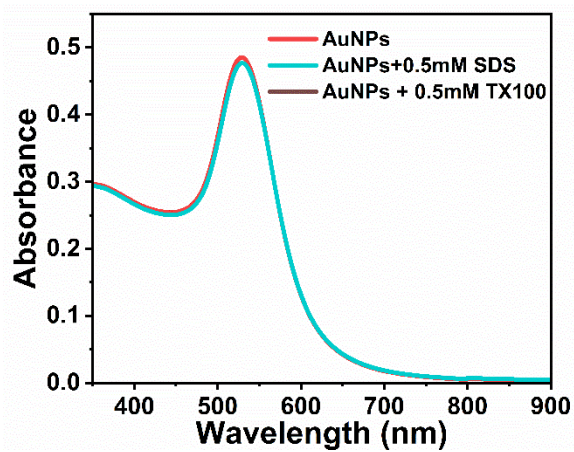
**Fig. S2** EDAX spectra of F-AgAu.



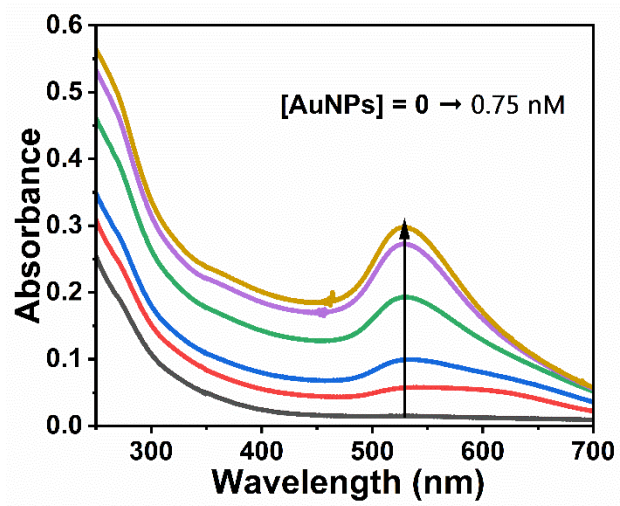
**Fig. S3** EDAX spectra of AuNPs.



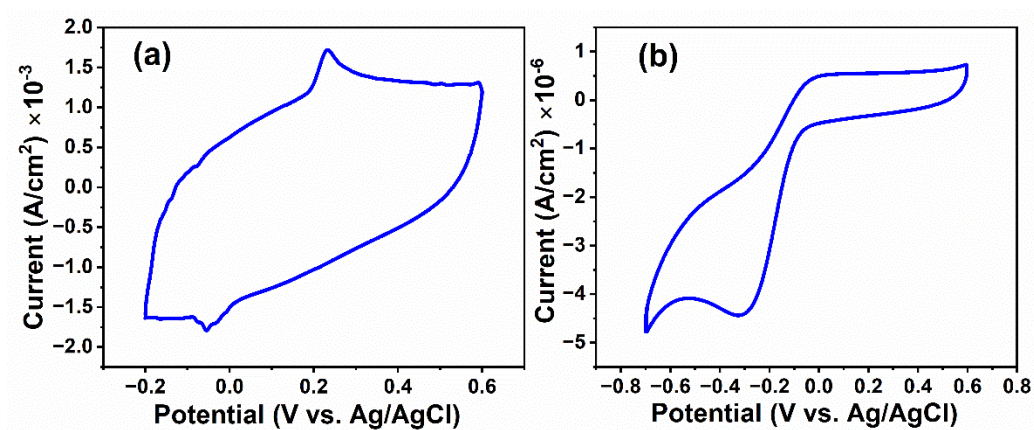
**Fig. S4** TEM image of AuNPs in the presence of CTAB.



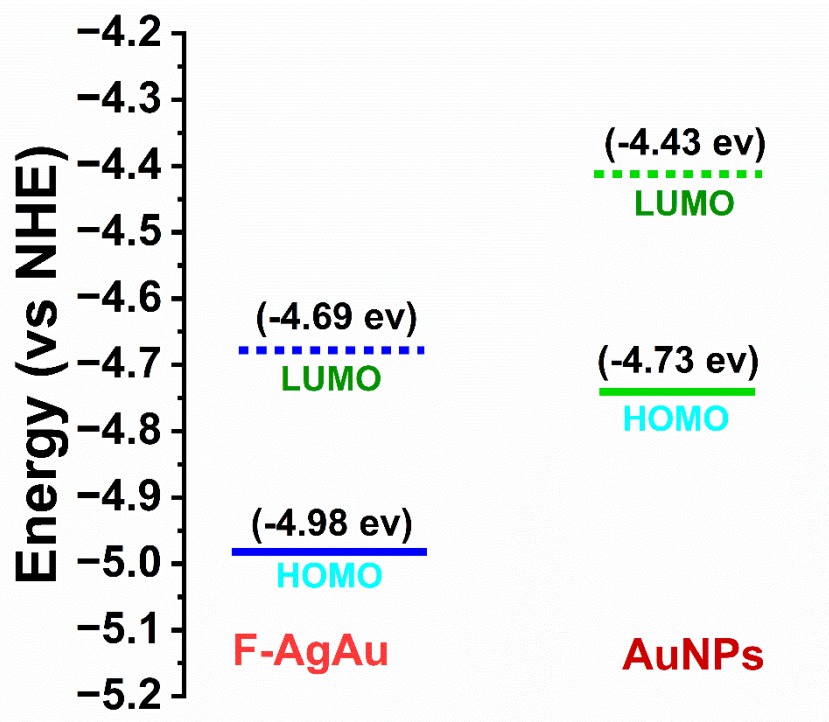
**Fig. S5** Absorption spectrum of AuNPs in absence and presence of SDS and TX100.



**Fig. S6** Absorption spectra of F-AgAu in absence and presence of increasing concentration of AuNPs.

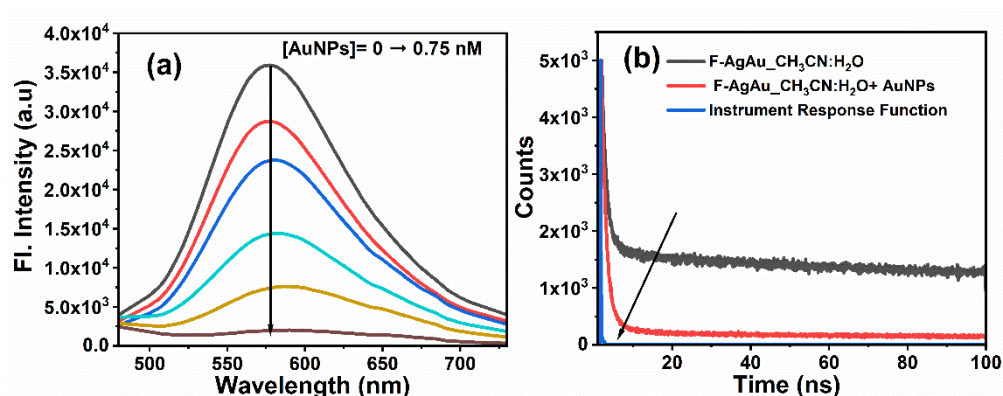


**Fig. S7** Cyclic voltammetric curves of (a) F-AgAu and (b) AuNPs.

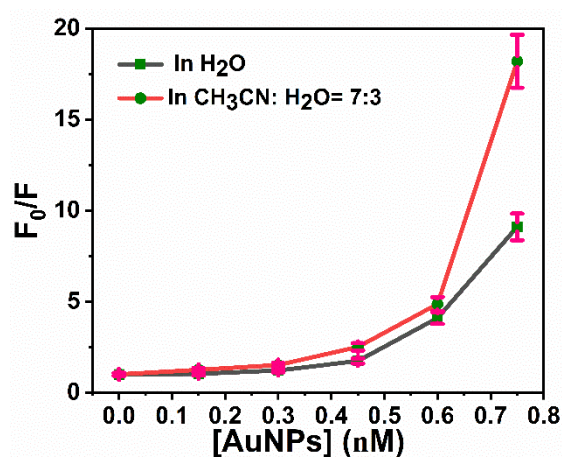


**Scheme S1.** The energy level diagram representing the HOMO and LUMO levels of F-AgAu and AuNPs.

## Effect of solvent polarity on PL quenching studies



**Fig. S8** (a) Fluorescence spectra of F-AgAu in the presence of increasing concentration of AuNPs in (a) 0.7:0.3 v/v CH<sub>3</sub>CN:H<sub>2</sub>O. (b) Time-resolved fluorescence decay curve of F-AgAu in the absence and presence of 0.45 nM AuNPs in 0.7:0.3 v/v CH<sub>3</sub>CN:H<sub>2</sub>O.



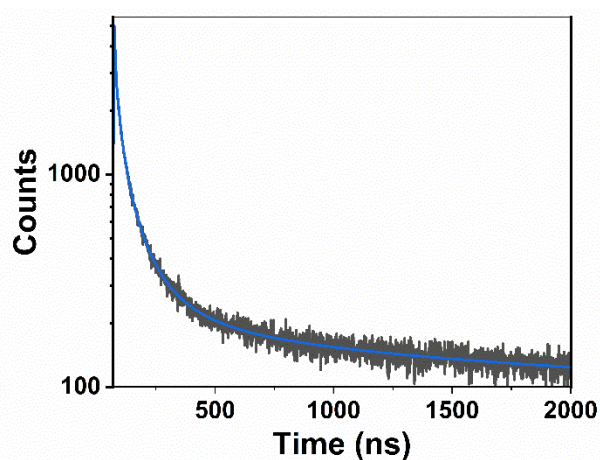
**Fig. S9** Stern-Volmer plot showing the relative changes in the photoluminescence intensity of F-AgAu as a function of AuNPs concentration in both H<sub>2</sub>O (green curve) and 0.7:0.3 v/v CH<sub>3</sub>CN:H<sub>2</sub>O (pink curve).



**Table S1.** PL decay analysis of F-AgAu in the presence of 0.45nM AuNPs in different solvents.

| Systems  | $\tau_1$ | $B_1$      | $\tau_2$ | $B_2$    | $\tau_3$ | $B_3$ | $\langle\tau\rangle$ | Efficiency |
|--|----------|------------|----------|----------|----------|-------|----------------------|------------|
| F-AgAu_H <sub>2</sub> O                                    | 0.35     | 45         | 4.00     | 23       | 57.47    | 32    | 19.48                |            |
| F-AgAu_ H <sub>2</sub> O + 0.45 nM AuNPs                   | 0.32     | 62         | 3.54     | 25       | 55.48    | 13    | 8.42                 | 56.7       |
| F-AgAu_ CH <sub>3</sub> CNH <sub>2</sub> O                 | 1.05     | 84%        | 4.16     | 5%       | 85.35    | 10%   | 9.85                 |            |
| F-AgAu_ CH <sub>3</sub> CNH <sub>2</sub> O + 0.45 nM AuNPs | 1.02     | 89.6<br>9% | 3.39     | 8.9<br>% | 45       | 1.4%  | 1.84                 | 81.3%      |

### Stretched exponential fitting of F-AgAu-AuNPs hybrid system



**Fig. S10** Stretched exponential fitting of F-AgAu-AuNPs hybrid system

In the case of resonance energy transfer between donor and acceptor molecules, by dipole-dipole or exchange mechanisms (Dexter), the donor fluorescence intensity decay  $I(t)$  is described by the modified stretched exponential function (Kohlrausch function)<sup>1-4</sup>

$$I(t) = \exp\left(-\frac{t}{\tau}\right) \exp\left[-a\left(\frac{t}{\tau}\right)^\beta\right] \quad (1)$$

It is also demonstrated that an experimental luminescence decay curve that can be adequately approximated by the stretched exponential function (1) can also be equally well described within the precision limits of the measurements by using following equation<sup>5</sup>

$$I(t) = A_1 \exp^{-a_1 t/\tau} + A_2 \exp(-a_2 (t/\tau)^\beta) \quad (2)$$

, with the same values of the parameter  $\beta$  in both functions and appropriate choice of the fitting parameters  $A_1$ ,  $A_2$ ,  $a_1$ , and  $a_2$ . The importance of Kohlrausch (or stretched exponential) relaxation function to explain relaxation of complex systems are well known. Specifically, in case of condensed matter luminescence it has been well documented by Bodunov and co-workers<sup>5</sup> that the resonance energy transfer will go via dipole-dipole mechanism when  $\beta \leq 0.5$ . The authors have analyzed this issue through theoretical investigations of the room temperature stretched exponential luminescence decay of colloidal quantum dots. The use of the eq. 1 for fitting the experimental non-exponential luminescence decay of colloidal quantum dot systems at room temperature have led to the separation into the exponential component of the decay (arising out of radiative and non-radiative transitions within the donor), and the non-exponential component (due to additional channels of energy relaxation such as RET). They have shown that a stretched exponential functional form of the luminescence decay with exponent  $\beta < 0.5$  can be explained by long-range dipole-dipole resonance energy transfer from donor to acceptor, whereas  $\beta > 0.5$  may arise due to contact mechanism of luminescence such as exchange energy transfer. We would also like to note here that several other researchers have also used the Kohlrausch function to describe that energy transfer mechanism is mediated via dipole-dipole interaction mechanism.<sup>6</sup> In our study for F-AgAu-AuNPs composite system, the value of the stretching parameter ( $\beta$ ) estimated through Kohlrausch function is found to be 0.272 which is less than 0.5 signifying that the energy transfer between donor and acceptor happens via dipole-dipole mechanism rather than following an exchange mechanism such as Dexter mechanism.

## References

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