A Laboratory-Demonstrated Model that Explains the Galactic Extended Red Emission: Graphene Exposed to Far-ultraviolet Light

Sheng-Lung Chou[1], Wen-Bing Shih[2], Min-Zhen Yang[2], Tzu-Ping Huang[1], Shu-Yu Lin[2], Meng-Yeh Lin[1], Wen-Jian Huang[1], Yin-Yu Lee[1], Yuan-Pern Lee[2], Yu-Jong Wu[1,2]

[1]*National Synchrotron Radiation Research Center, Taiwan*
[2]*Department of Applied Chemistry, National Yang Ming Chiao Tung University, Taiwan*

Extended red emission (ERE) is a broad feature in spectral region 500~900 nm commonly observed in a wide range of circumstellar and interstellar environments [1]. Although the observational constraints for ERE are well established, definitive identifications of the carriers and associated processes complying these constraints remain unanswered. We report a plausible two-step model involving far-UV irradiated single-layer graphene (SLG), considered as large polycyclic aromatic hydrocarbons, to meet these constraints and supported by laboratory experiments. The far-UV-treated SLG, producing structural defects and graphene quantum dots, showed photoluminescence excitation spectrum extending from far-UV to UV–visible region, hence meeting the requirements of far-UV light and high photon-conversion efficiency. Furthermore, a photoluminescence band shifted from ~585 nm to ~750 nm for high-dose-exposed SLG agrees with the observed red shift of the ERE band in regions under a greater far-UV radiation density [2,3]

References

[1] A. N. Witt & T. S.-Y. Lai, 2020, Astrophys. Space Sci. 365, 58
[2] S.-L. Chou, M.-Y. Lin, S.-Y. Lin, W.-J. Huang, T.-P. Huang, Y.-C. Lee, & Y.-J. Wu, 2020, ApJ 901, 103.
[3] S.-L. Chou, W.-B. Shih, M.-Z. Yang, T.-P. Huang, S.-Y. Lin, M.-Y. Lin, W.-J. Huang, C. M. Chu, W.-Y. W, Y.-Y. Lee, Y.-P. Lee, & Y.-J. Wu, 2023, ApJ 944, 18