C_{60} cation as the carrier of the λ9577 Å and λ9632 Å diffuse interstellar bands

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Ever since they were first detected over 100 years ago, the mysterious diffuse interstellar bands (DIBs), a set of several hundred broad absorption features seen against distant stars in the optical and near-infrared wavelength range, largely remain unidentified. The close match, both in wavelengths and in relative strengths, recently found between the experimental absorption spectra of gas-phase buckminsterfullerene ions (C_{60}^+) and four DIBs at λ9632 Å, λ9577 Å, λ9428 Å and λ9365 Å (and, to a lesser degree, a weaker DIB at λ9348 Å) suggests that C_{60}^+ is a promising carrier for these DIBs. However, arguments against the C_{60}^+ identification remain and are mostly concerned with the large variation in the intensity ratios of the λ9632 Å and λ9577 Å DIBs. We search for these DIBs in the X-shooter archival data of the European Southern Observatory's Very Large Telescope, and identify the λ9632 Å, λ9577 Å, λ9428 Å and λ9365 Å DIBs in a sample of 25 stars. While the λ9428 Å and λ9365 Å DIBs are too noisy to allow any reliable analysis, the λ9632 Å and λ9577 Å DIBs are unambiguously detected and, after correcting for telluric water vapor absorption, their correlation can be used to probe their origin. To this end, we select a subsample of nine hot, O- or B0-type stars of which the stellar Mg II contamination to the λ9632 Å DIB is negligibly small. We find that their equivalent widths, after being normalized by reddening to eliminate their common correlation with the density of interstellar clouds, exhibit a tight, positive correlation. This supports C_{60}^+ as the carrier of the λ9632 Å and λ9577 Å DIBs.