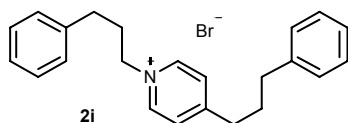


# Pyridinium Cation- $\pi$ Interaction: Sensing of alkylating agents

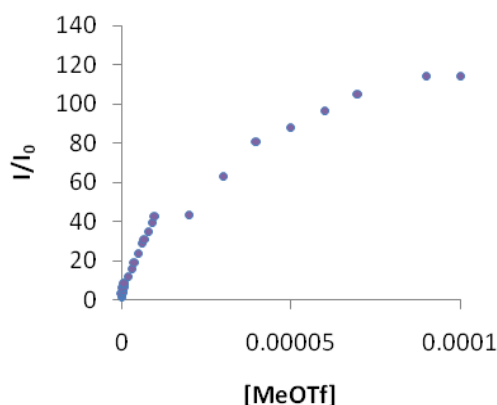
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## Representative Synthetic Procedure:



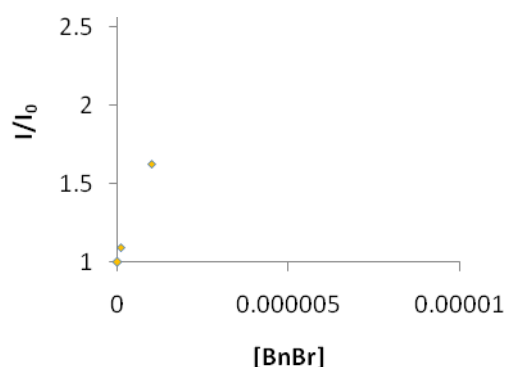
*Synthesis of 1,4-bis(3-phenylpropyl)pyridin-1-ium bromide 2i:* 4-(3-Phenylpropyl)pyridine (0.5 mL, 2.6 mmol), was dissolved in acetone (10 mL), to which an excess of (3-bromopropyl)benzene (8 mmol). To insure complete reaction the mixture was heated at reflux for overnight. Upon cooling to room temperature a white precipitate formed which was collected by filtration, washed with diethyl ether and dried *in vacuo* to furnish the title compound as a white solid in 86% yield (0.89 g, 2.25 mmol). Whilst NMR spectroscopy revealed the isolated product to be essentially pure, recrystallisation from acetone provided crystals suitable for single crystal X-ray diffraction analysis. *m/z* TOF ES<sup>+</sup> 316.2 ([M-Br<sup>-</sup>], 100%); Acc Mass C<sub>23</sub>H<sub>26</sub>N<sup>+</sup> requires 316.2065 found 316.2078.  $\delta_{\text{H}}$  (400 MHz, CDCl<sub>3</sub>) 1.92 (CH<sub>2</sub>, *quin*, 2H), 2.31 (CH<sub>2</sub>, *quin*, 2H), 2.60 (CH<sub>2</sub>, *t*, 2H), 2.69-2.82 (2 x CH<sub>2</sub>, *m*, 4H), 4.90 (CH<sub>2</sub>, *t*, 2H), 7.0-7.3 (phenyl CH overlapping with residual CHCl<sub>3</sub>, *m*, >10H), 7.62 (pyridinium CH, *d*, 2H), 9.20 (pyridinium CH, *d*, 2H);  $\delta_{\text{C}}$  (100 MHz, CDCl<sub>3</sub>, *pendant*) 30.9 (-ve), 32.1 (-ve), 33.0 (-ve), 35.1 (-ve), 60.7 (-ve), 126.5 (+ve), 127.8 (+ve), 128.4 (+ve), 128.7 (+ve), 139.5 (-ve), 140.3 (-ve), 144.3 (+ve), 162.7 (-ve).

## Supplementary Plots: MeOTf and BnBr addition



**Supplementary Plot 1:** Fluorescence  $F/F_0$  at 400nm for addition of MeOTf (0 to  $1 \times 10^{-4}$  M) to pyridine 4-(3-phenylpropyl)pyridine ( $1 \times 10^{-4}$  M) in CH<sub>2</sub>Cl<sub>2</sub> ( $\lambda_{\text{ex}} = 260$  nm).

Fluorescence recorded 4min after addition of alkylating agent (room temp).



**Supplementary Plot 2:** Fluorescence  $F/F_0$  at 400nm for addition of BnBr to pyridine 4-(3-phenylpropyl)pyridine ( $1 \times 10^{-5}$  M) in CH<sub>2</sub>Cl<sub>2</sub> ( $\lambda_{\text{ex}} = 260$  nm).

Fluorescence recorded 180 min after addition of alkylating agent, 12 hr experiment, 0.1 equiv added (room temp).

## Representative Fluorescence Procedure:

4-(Phenylpropyl)-pyridine **1** was dissolved in the specified solvent to produce a solution of the specified concentration. Alkylating agent, corresponding to the specified concentration was added and the solution maintained at the specified temperature for the specified time and fluorescence spectra recorded. Fluorescence spectroscopy measurements were performed using a Gilden Photonics FluoroSENS SENS-

9000 instrument, with Starna Silica (quartz) cuvettes with 10 mm path lengths and four polished faces, 3 mL of solution was used, and data was processed with the FluoroSENS 1.6 software package.

**X-Ray Crystallography 2i:** Suitable crystals were selected and a dataset for **2i** was measured on a Bruker KappaCCD diffractometer at the window of a Bruker FR591 rotating anode ( $\lambda_{\text{Mo-K}\alpha} = 0.71073 \text{ \AA}$ ) at 120 K. The data collection was driven by COLLECT<sup>1</sup> and processed by DENZO.<sup>2</sup> An absorption correction was applied using SADABS.<sup>3</sup> The structure was solved in SHELXS-97<sup>4</sup> and were refined by a full-matrix least-squares procedure on  $F^2$  in SHELXL-97.<sup>4</sup> All non-hydrogen atoms were refined with anisotropic displacement parameters. All hydrogen atoms were added at calculated positions and refined by use of a riding model with isotropic displacement parameters based on the equivalent isotropic displacement parameter ( $U_{\text{eq}}$ ) of the parent atom. Figures were produced using ORTEP3 for Windows<sup>5</sup> and Mercury CSD 2.3<sup>6</sup> while structural analysis was carried out in PLATON.<sup>7</sup> The centre of the pyridinium molecule is located on an inversion centre such that half the molecule is crystallographically unique. Atoms C(10) and N(1) are present on the same site at 50 % occupancy each. The *R*-factor and GOF are rather high. It is not clear why this is the case, although the choice of space group was difficult and there are several systematic absence violations. A refinement in space group *P1* indicated the presence of a centre of inversion in the centre of the N(1), C(10)-C(12) ring, with N(1) and C(10) occupying the same site at 50 % occupancy each. Refinements in several other space groups was attempted, along with searches for merohedral twinning, but none of these was significantly better than the refinement in *Pbca*, and PLATON always indicated that the symmetry of the structure was consistent with the space group *Pbca*. The CIF for the crystal structure of **2i** has been deposited with the CCDC and has been given the deposition number 775629.

The crystal packing shows that the bromine anions occupy channels in the structure lying perpendicular to the crystallographic *c* axis. Similarly to the previously reported phenylpropylpyridine *N*-oxide and *N*-methyl iodide,<sup>8</sup> electrostatic cation-anion interactions dominate the packing with bromine anions surrounded by the central pyridine groups of four cations with the average of the six closer Br(1)-N(1)/C(10) distances being 4.04 (1) Å. As is the case for previously reported *tert*-butyl-substituted bis(pyridiniopropyl)benzene derivatives,<sup>9</sup> whilst no inter- or intra- molecular face-face interactions are apparent a C-H... $\pi$  interaction between the phenyl group C(1)-C(6) and the C(9)-H(9a) unit (centroid of phenyl group labelled CT(1): H(9a)...CT(1) = 3.0 Å, C(9)...CT(1) = 3.9 Å, C(9)-H(9a)...CT(1) = 152°) is present.

**Table ST1. X-Ray Crystallography Experimental Data**

|                                    |  |
|------------------------------------|--|
| Empirical Formula                  | C <sub>23</sub> H <sub>26</sub> N·Br   |
| Formula Weight                     | 396.36                                 |
| Temperature (K)                    | 120 (2)                                |
| Crystal Size (mm)                  | 0.42 x 0.07 x 0.06                     |
| Crystal System                     | Orthorhombic                           |
| Space Group                        | <i>Pbca</i>                            |
| <i>a</i> ; <i>b</i> ; <i>c</i> (Å) | 7.3748 (2) ; 10.0622 (2) ; 25.6743 (8) |
| $\alpha$ ; $\beta$ ; $\gamma$ (°)  | 90 ; 90 ; 90                           |

|  |  |
|--|--|
| $V$ ( $\text{\AA}^3$ )   | 1905.21 (9)  |
| $Z$ ; $Z'$   | 4 ; 0.5  |
| Density (Calculated) ( $\text{Mg m}^{-3}$ )                      | 1.382  |
| Absorption Coefficient ( $\text{MoK}\alpha$ , $\text{mm}^{-1}$ ) | 2.163  |
| Max. and Min. Transmission                                       | 0.8812 and 0.4636  |
| $F(000)$   | 824  |
| $\theta$ Range for Data Collection ( $^\circ$ )                  | 3.17 – 27.48   |
| Index Ranges   | $-9 \leq h \leq 9$ , $-13 \leq k \leq 12$ , $-33 \leq l \leq 33$ |
| Reflections Collected  | 22489  |
| Independent Reflections  | 2183 [ $R_{int} = 0.0468$ ]                                      |
| Measured Reflections with $I \geq 2\sigma(I)$                    | 2047   |
| Completeness to $\theta_{max}$                                   | 99.9   |
| Data / Restraints / Parameters                                   | 2183 / 63 / 115  |
| Goodness-of-Fit on $F^2$   | 1.439  |
| Final $R$ Indices (Observed Data)                                | $R1 = 0.0950$ , $wR2 = 0.2009$                                   |
| Final $R$ Indices (All Data)                                     | $R1 = 0.0986$ , $wR2 = 0.2020$                                   |
| Largest Diff. Peak ; Hole ( $e \text{\AA}^{-3}$ )                | 0.525 ; -0.810   |

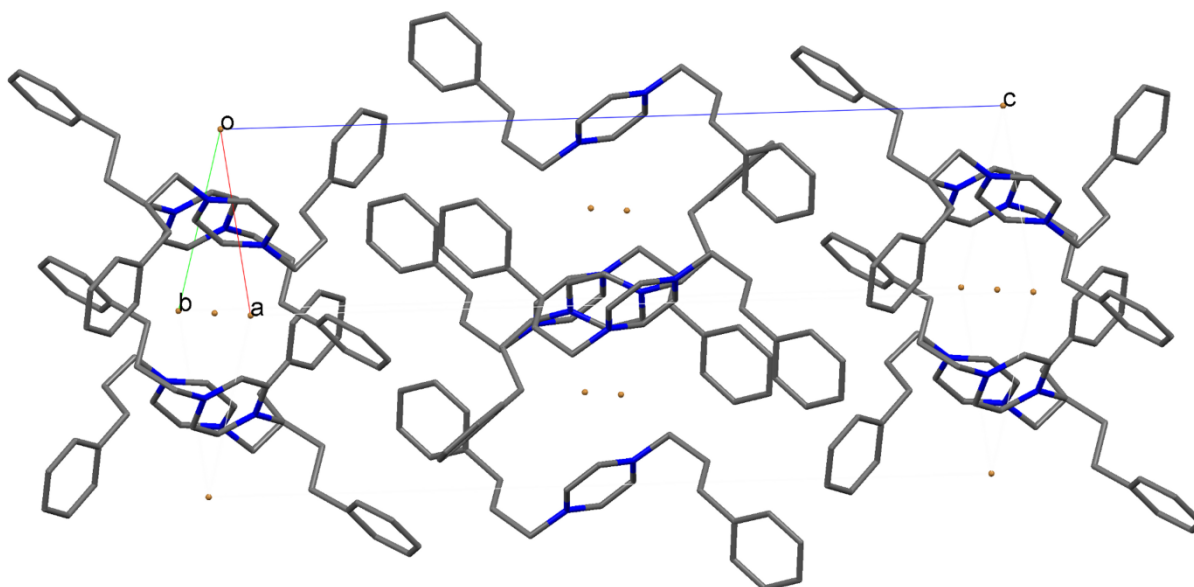


Figure SF1: The crystal packing in 2i with carbon atoms shown in grey, atoms N(1)/C(10) shown in blue and bromine shown in brown. Hydrogen atoms have been omitted for clarity.

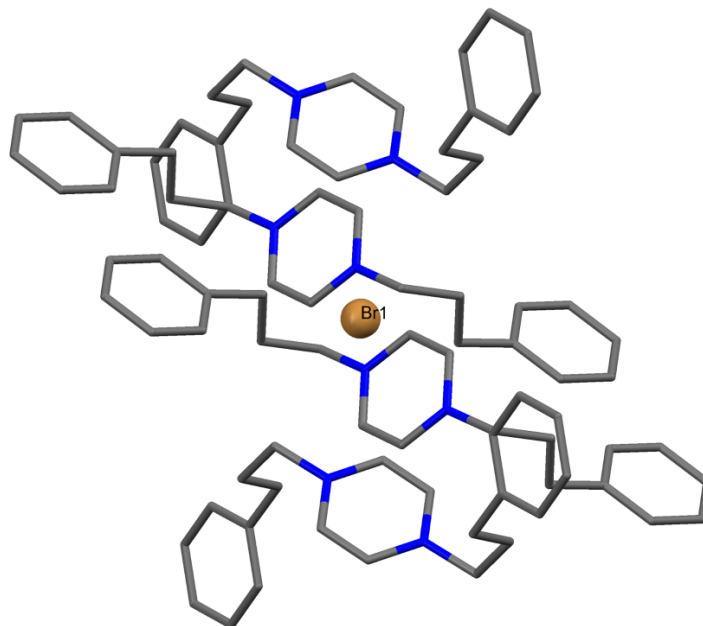


Figure SF2: The bromine anion in 2i is surrounded by four cations, with the average of the six closest Br(1)...N(1)/C(10) distances being 4.04 (1) Å. Carbon atoms are shown in grey, atoms N(1)/C(10) are shown in blue and the bromine anion is shown in brown. Hydrogen atoms have been omitted for clarity.

Table ST2. Selected bond lengths (Å), angles (°) and torsion angles (°) for 2i

|                           |            |
|---------------------------|------------|
| C(4)–C(7)                 | 1.506 (9)  |
| C(7)–C(8)                 | 1.547 (9)  |
| C(8)–C(9)                 | 1.529 (9)  |
| C(9)–N(1)/C(10)           | 1.490 (9)  |
| N(1)/C(10)–C(11)          | 1.371 (8)  |
| N(1)/C(10)–C(12)          | 1.379 (8)  |
| C(4)–C(7)–C(8)            | 111.9 (5)  |
| C(8)–C(9)–N(1)/C(10)      | 111.5 (5)  |
| C(9)–N(1)/C(10)–C(11)     | 118.9 (5)  |
| C(9)–N(1)/C(10)–C(12)     | 122.2 (5)  |
| C(11)–N(1)/C(10)–C(12)    | 118.9 (6)  |
| C(4)–C(7)–C(8)–C(9)       | -171.0 (5) |
| C(7)–C(8)–C(9)–N(1)/C(10) | 62.2 (7)   |

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**Author contributions:**

JSF, SDB and TDJ conceived the idea, planned experiments and wrote the paper

LM analysed the X-ray crystal diffraction data

SY and JSF corroborated the experimental data

PA performed the first Mel fluorescence titration

CA, WC, SAE, YN completed the manuscript including info in Schemes