UV-VIS Titration Data for paper

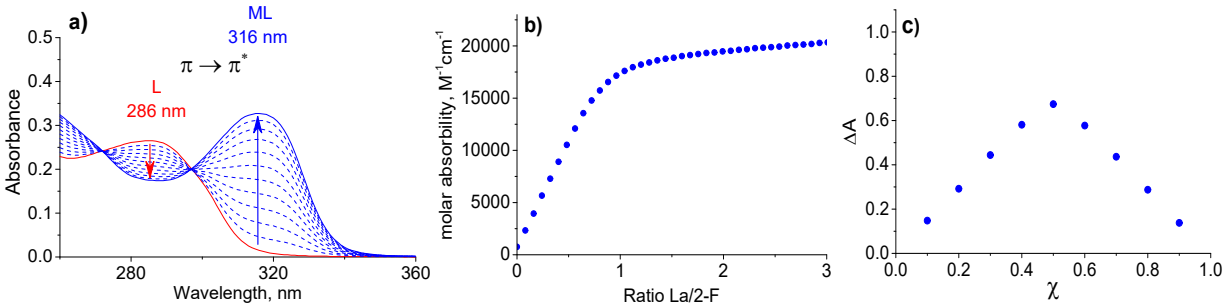
Bipyridyldicarboxamides and f-metals: Electron effects influence the structure, stability, separation properties, and photophysics

Nataliya E. Borisova,*[a] Anastasia V. Kharcheva,[a, b] Tsagana B. Sumyanova,[a] Victoria Gontcharenko,[a] Pert I. Matveev,[a] Leonid Starostin[a], Alexander Trigub[a], Alexey V. Ivanov,[a] and Svetlana V. Patsaeva[b]

UV-vis Titration Data in "dry" CH_3CN

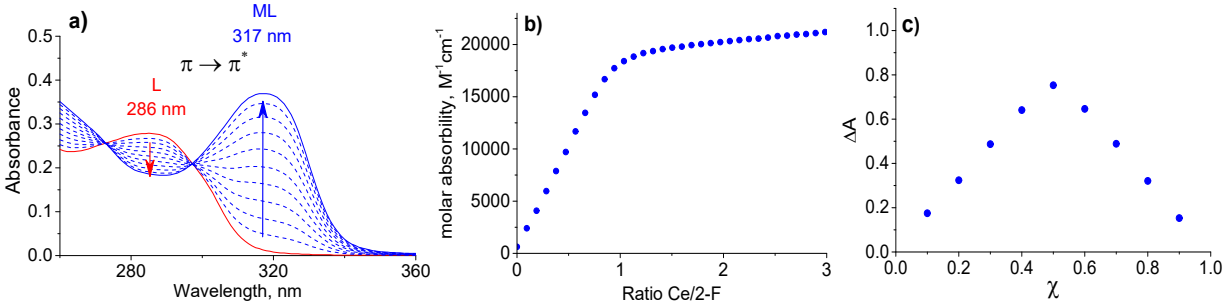
2-F ligand with trivalent lanthanide ions

2-F with $La(NO_3)_3 \cdot 6H_2O$



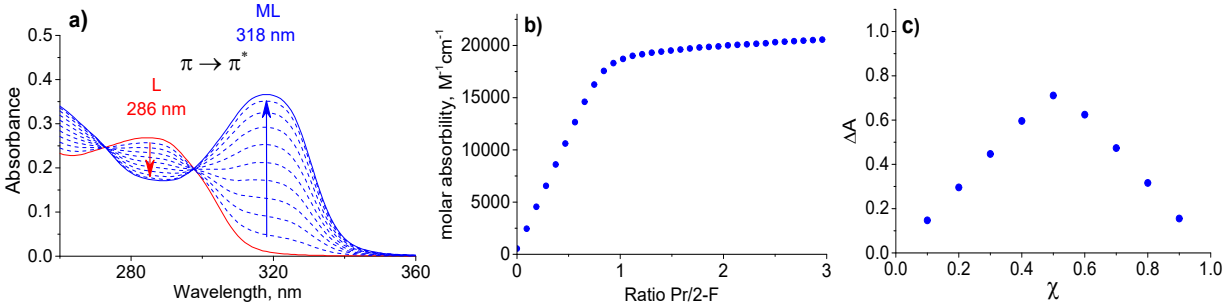
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.22 mM titrant solution $La(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $1.97 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $La(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[La2\text{-}F](NO_3)_3$; b) titration curve at 316 nm; c) the method of continuous variation for 0,094 mM 2-F with 0,094 mM $La(NO_3)_3 \cdot 6H_2O$ at 316 nm.

2-F with $Ce(NO_3)_3 \cdot 6H_2O$



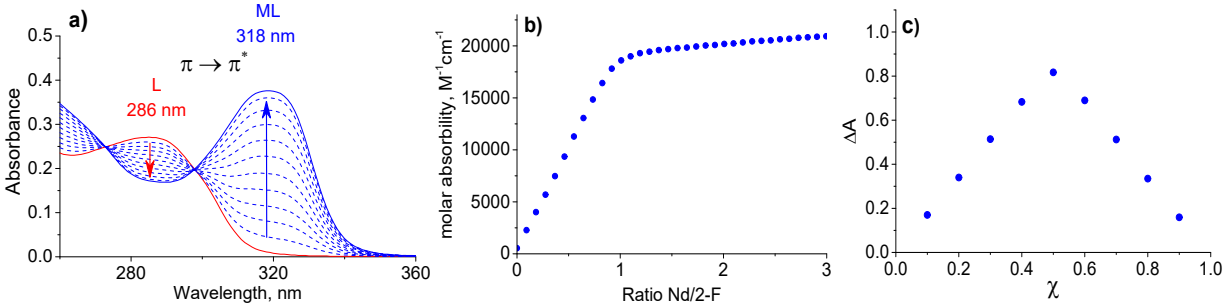
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.79 mM titrant solution $Ce(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $2.08 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Ce(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Ce2\text{-}F](NO_3)_3$; b) titration curve at 317 nm; c) the method of continuous variation for 0,099 mM 2-F with 0,099 mM $Ce(NO_3)_3 \cdot 6H_2O$ at 317 nm.

2-F with $Pr(NO_3)_3 \cdot 6H_2O$



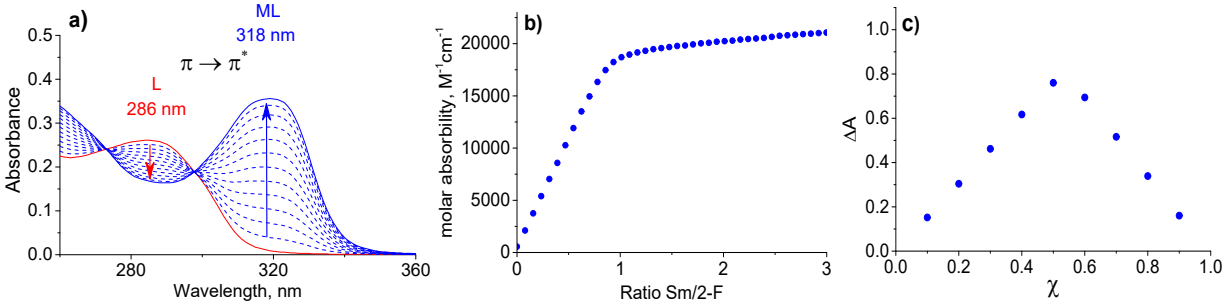
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.76 mM titrant solution $Pr(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $2.00 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Pr(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Pr2\text{-}F](NO_3)_3$; b) titration curve at 318 nm; c) the method of continuous variation for 0,093 mM 2-F with 0,093 mM $Pr(NO_3)_3 \cdot 6H_2O$ at 318 nm.

2-F with $Nd(NO_3)_3 \cdot 6H_2O$



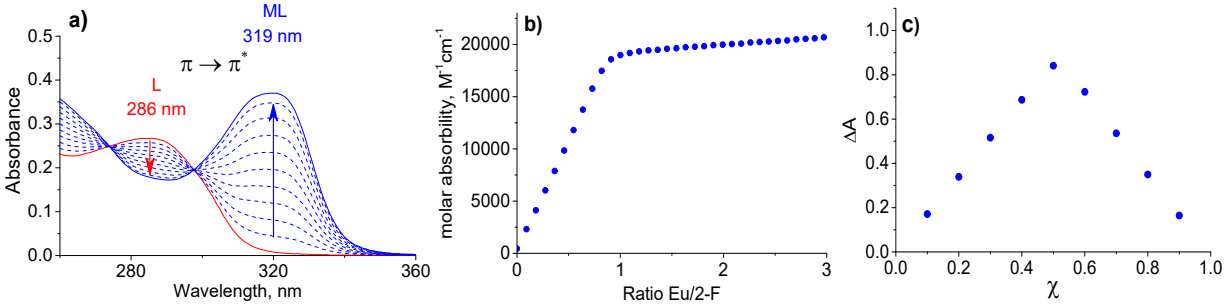
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.69 mM titrant solution $Nd(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $2.02 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Nd(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Nd2\text{-}F](NO_3)_3$; b) titration curve at 318 nm; c) the method of continuous variation for 0,108 mM 2-F with 0,108 mM $Nd(NO_3)_3 \cdot 6H_2O$ at 318 nm.

2-F with $Sm(NO_3)_3 \cdot 6H_2O$



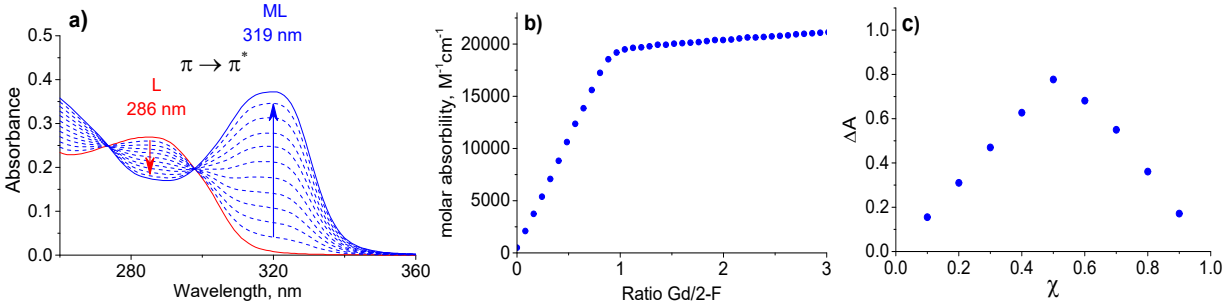
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.13 mM titrant solution $Sm(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $1.95 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Sm(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Sm2\text{-}F](NO_3)_3$; b) titration curve at 318 nm; c) the method of continuous variation for 0,098 mM 2-F with 0,098 mM $Sm(NO_3)_3 \cdot 6H_2O$ at 318 nm.

2-F with $Eu(NO_3)_3 \cdot 6H_2O$



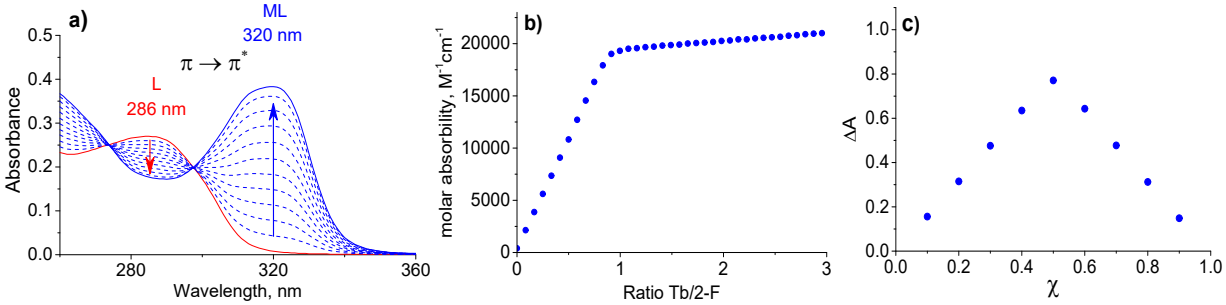
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.66 mM titrant solution $Eu(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $1.99 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Eu(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Eu2\text{-}F](NO_3)_3$; b) titration curve at 319 nm; c) the method of continuous variation for 0,108 mM 2-F with 0,108 mM $Eu(NO_3)_3 \cdot 6H_2O$ at 319 nm.

2-F with $Gd(NO_3)_3 \cdot 6H_2O$



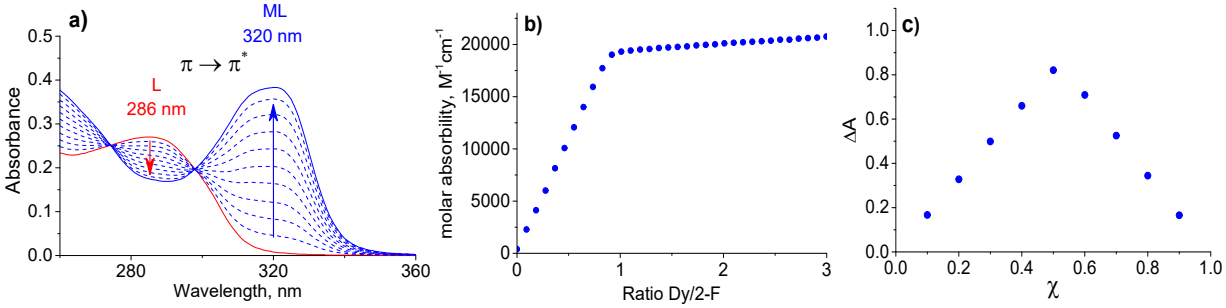
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.23 mM titrant solution $Gd(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $2.01 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Gd(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Gd2\text{-}F](NO_3)_3$; b) titration curve at 319 nm; c) the method of continuous variation for 0,098 mM 2-F with 0,098 mM $Gd(NO_3)_3 \cdot 6H_2O$ at 319 nm.

2-F with $Tb(NO_3)_3 \cdot 5H_2O$



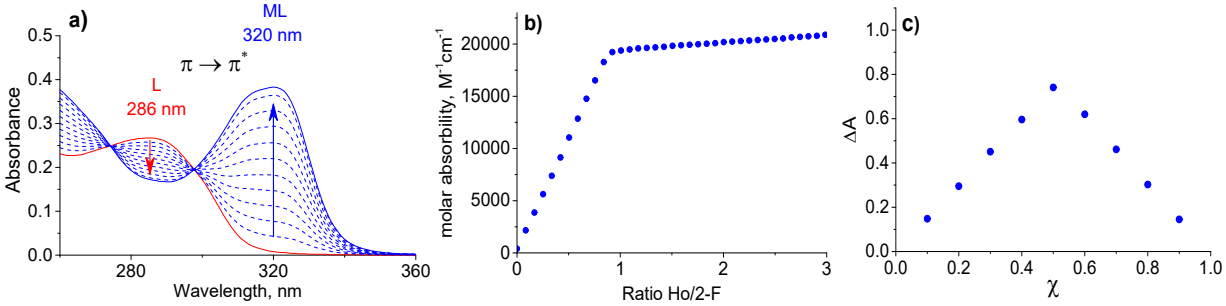
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.34 mM titrant solution $Tb(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $2.01 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Tb(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Tb2\text{-}F](NO_3)_3$; b) titration curve at 320 nm; c) the method of continuous variation for 0,098 mM 2-F with 0,098 mM $Tb(NO_3)_3 \cdot 5H_2O$ at 320 nm.

2-F with $Dy(NO_3)_3 \cdot 5H_2O$



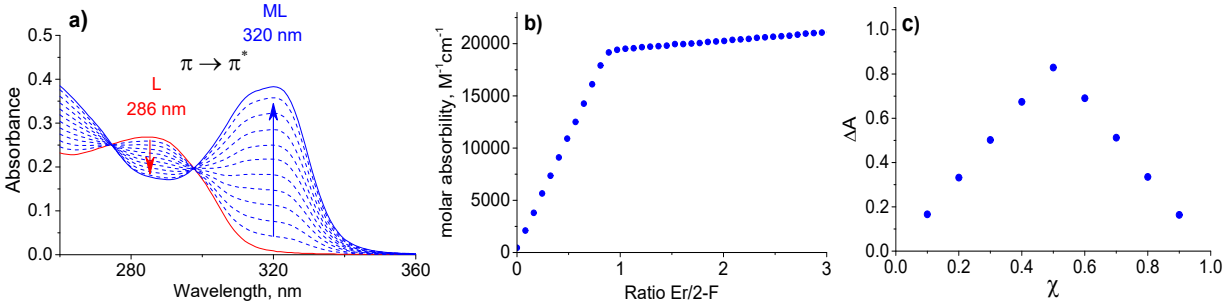
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.69 mM titrant solution $Dy(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $2.01 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Dy(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Dy2\text{-}F](NO_3)_3$; b) titration curve at 320 nm; c) the method of continuous variation for 0,104 mM 2-F with 0,104 mM $Dy(NO_3)_3 \cdot 5H_2O$ at 320 nm.

2-F with $Ho(NO_3)_3 \cdot 5H_2O$



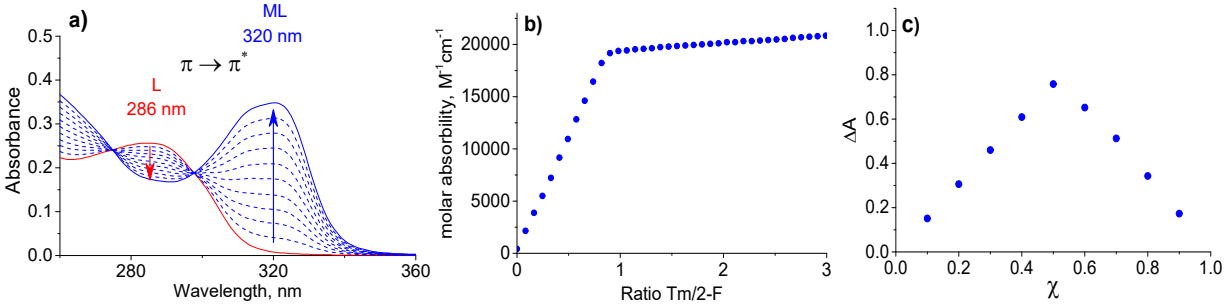
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.38 mM titrant solution $Ho(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $1.99 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Ho(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Ho2\text{-}F](NO_3)_3$; b) titration curve at 320 nm; c) the method of continuous variation for 0,096 mM 2-F with 0,096 mM $Ho(NO_3)_3 \cdot 5H_2O$ at 320 nm.

2-F with $Er(NO_3)_3 \cdot 5H_2O$



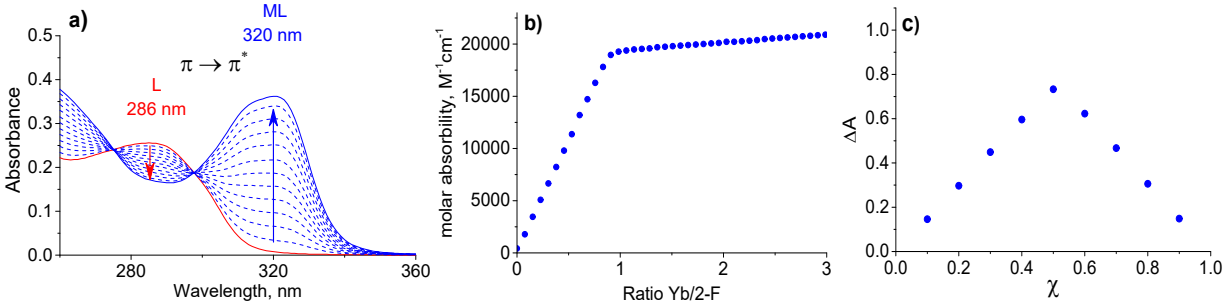
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.25 mM titrant solution $Er(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $2.00 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Er(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Er2\text{-}F](NO_3)_3$; b) titration curve at 320 nm; c) the method of continuous variation for 0,106 mM 2-F with 0,106 mM $Er(NO_3)_3 \cdot 5H_2O$ at 320 nm.

2-F with $Tm(NO_3)_3 \cdot 5H_2O$



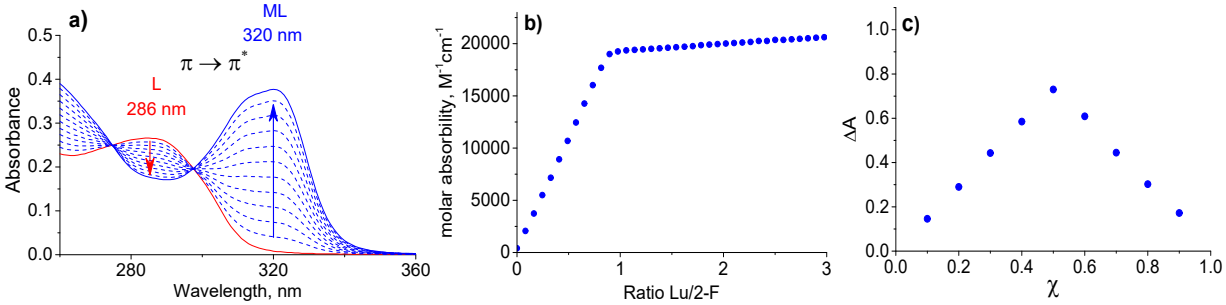
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.19 mM titrant solution $Tm(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $1.91 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Tm(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Tm2\text{-}F](NO_3)_3$; b) titration curve at 320 nm; c) the method of continuous variation for 0,094 mM 2-F with 0,094 mM $Tm(NO_3)_3 \cdot 5H_2O$ at 320 nm.

2-F with $Yb(NO_3)_3 \cdot 5H_2O$



Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 2.95 mM titrant solution $Yb(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $1.91 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Yb(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Yb2\text{-}F](NO_3)_3$; b) titration curve at 320 nm; c) the method of continuous variation for 0,094 mM 2-F with 0,094 mM $Yb(NO_3)_3 \cdot 5H_2O$ at 320 nm.

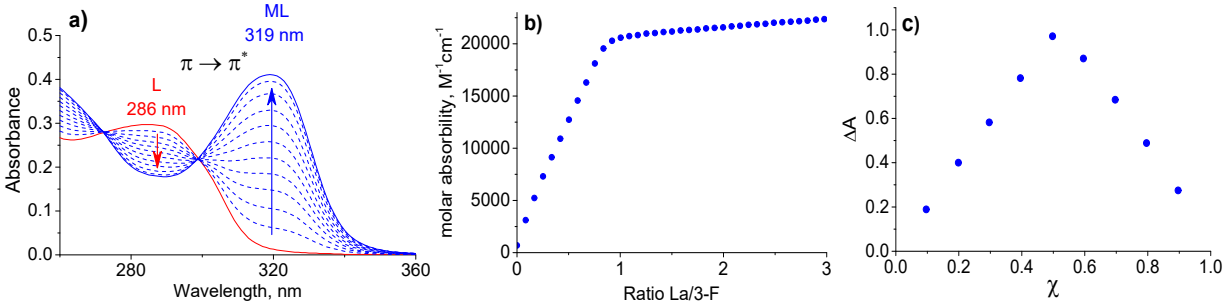
2-F with $Lu(NO_3)_3 \cdot 4H_2O$



Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.27 mM titrant solution $Lu(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $1.98 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Lu(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Lu2\text{-}F](NO_3)_3$; b) titration curve at 320 nm; c) the method of continuous variation for 0,097 mM 2-F with 0,097 mM $Lu(NO_3)_3 \cdot 5H_2O$ at 320 nm.

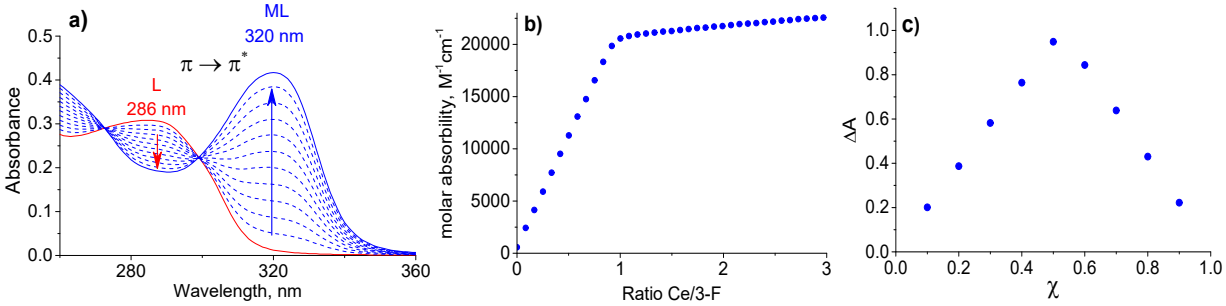
3-F ligand with trivalent lanthanide ions

3-F with $La(NO_3)_3 \cdot 6H_2O$



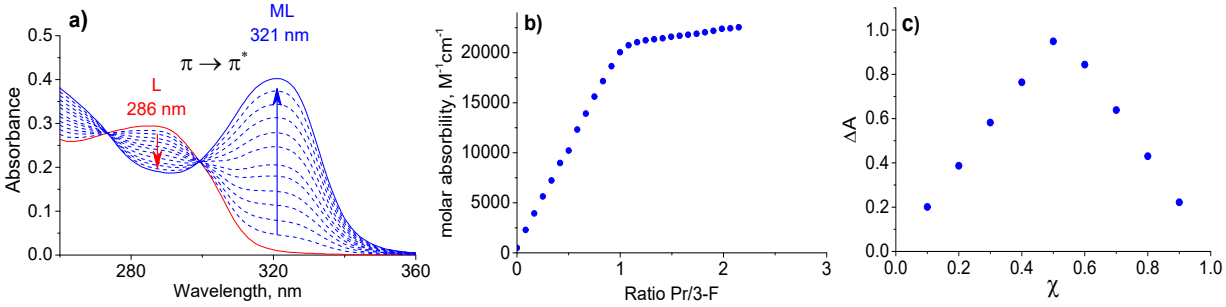
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.37 mM titrant solution $La(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $2.03 \cdot 10^{-2}$ mM 3-F: a) spectrophotometric data, where red line – 3-F spectrum, blue dashed lines – aliquots of $La(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[La3\text{-}F](NO_3)_3$; b) titration curve at 319 nm; c) the method of continuous variation for 0,122 mM 3-F with 0,127 mM $La(NO_3)_3 \cdot 6H_2O$ at 319 nm.

3-F with $Ce(NO_3)_3 \cdot 6H_2O$



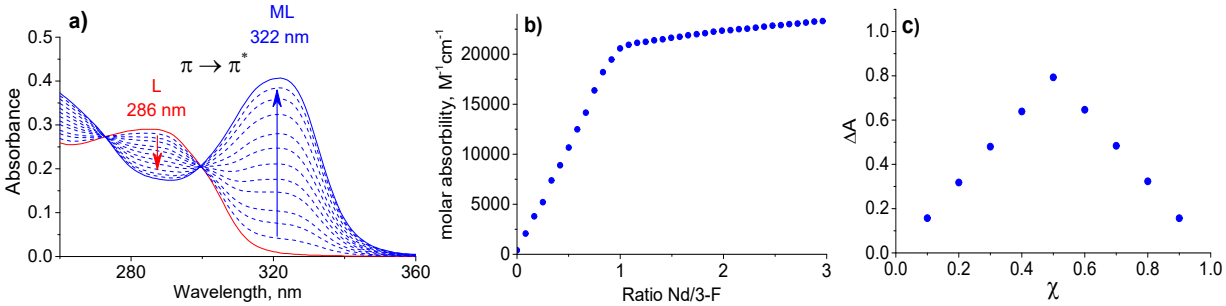
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.36 mM titrant solution $Ce(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $2.10 \cdot 10^{-2}$ mM 3-F: a) spectrophotometric data, where red line – 3-F spectrum, blue dashed lines – aliquots of $Ce(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Ce3\text{-}F](NO_3)_3$; b) titration curve at 320 nm; c) the method of continuous variation for 0,117 mM 3-F with 0,117 mM $Ce(NO_3)_3 \cdot 6H_2O$ at 320 nm.

3-F with $Pr(NO_3)_3 \cdot 6H_2O$



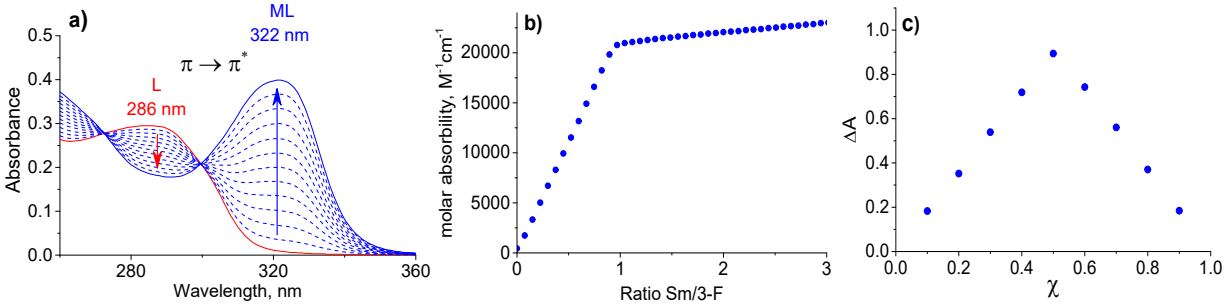
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.35 mM titrant solution $Pr(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $2.00 \cdot 10^{-2}$ mM 3-F: a) spectrophotometric data, where red line – 3-F spectrum, blue dashed lines – aliquots of $Pr(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Pr3\text{-}F](NO_3)_3$; b) titration curve at 321 nm; c) the method of continuous variation for 0,101 mM 3-F with 0,101 mM $Pr(NO_3)_3 \cdot 6H_2O$ at 321 nm.

3-F with $Nd(NO_3)_3 \cdot 6H_2O$



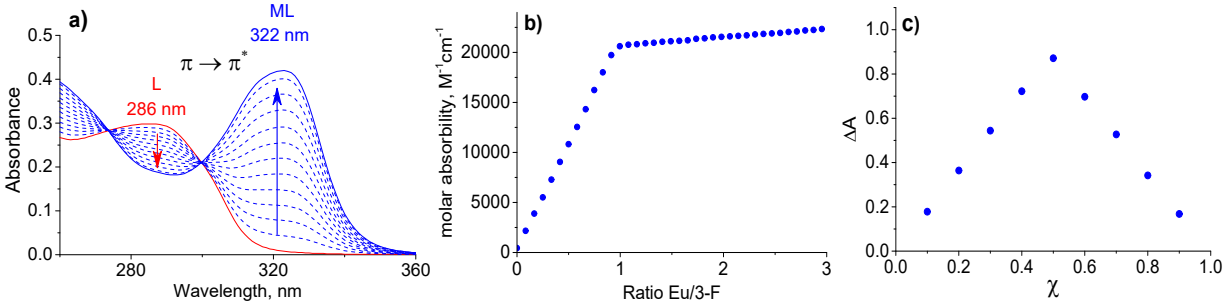
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.35 mM titrant solution $Nd(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $1.98 \cdot 10^{-2}$ mM 3-F: a) spectrophotometric data, where red line – 3-F spectrum, blue dashed lines – aliquots of $Nd(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Nd3\text{-}F](NO_3)_3$; b) titration curve at 322 nm; c) the method of continuous variation for 0,097 mM 3-F with 0,097 mM $Nd(NO_3)_3 \cdot 6H_2O$ at 322 nm.

3-F with $Sm(NO_3)_3 \cdot 6H_2O$



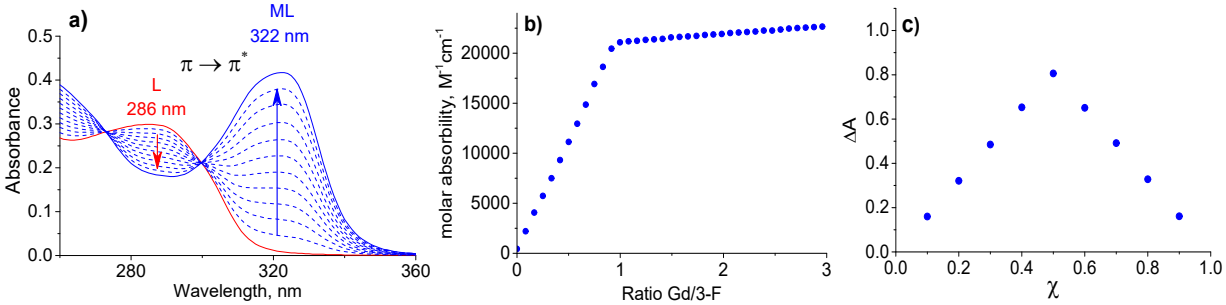
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.00 mM titrant solution $Sm(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $2.01 \cdot 10^{-2}$ mM 3-F: a) spectrophotometric data, where red line – 3-F spectrum, blue dashed lines – aliquots of $Sm(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Sm3\text{-}F](NO_3)_3$; b) titration curve at 322 nm; c) the method of continuous variation for 0,109 mM 3-F with 0,109 mM $Sm(NO_3)_3 \cdot 6H_2O$ at 322 nm.

3-F with $Eu(NO_3)_3 \cdot 6H_2O$



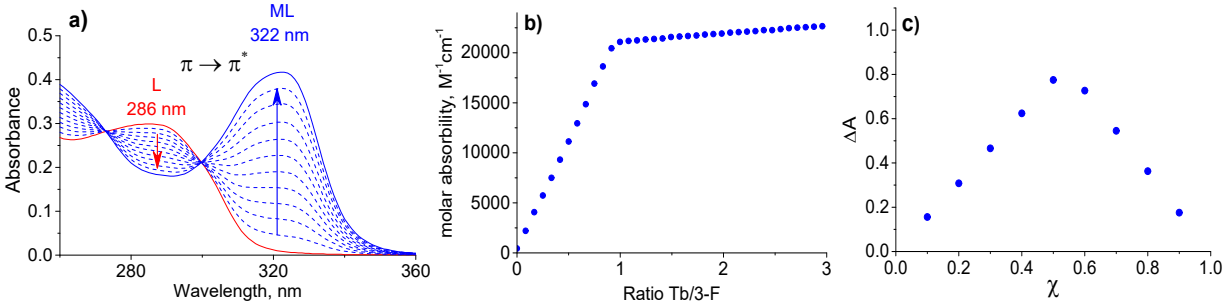
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.34 mM titrant solution $Eu(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $2.03 \cdot 10^{-2}$ mM 3-F: a) spectrophotometric data, where red line – 3-F spectrum, blue dashed lines – aliquots of $Eu(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Eu3\text{-}F](NO_3)_3$; b) titration curve at 322 nm; c) the method of continuous variation for 0,109 mM 3-F with 0,109 mM $Eu(NO_3)_3 \cdot 6H_2O$ at 322 nm.

3-F with $Gd(NO_3)_3 \cdot 6H_2O$



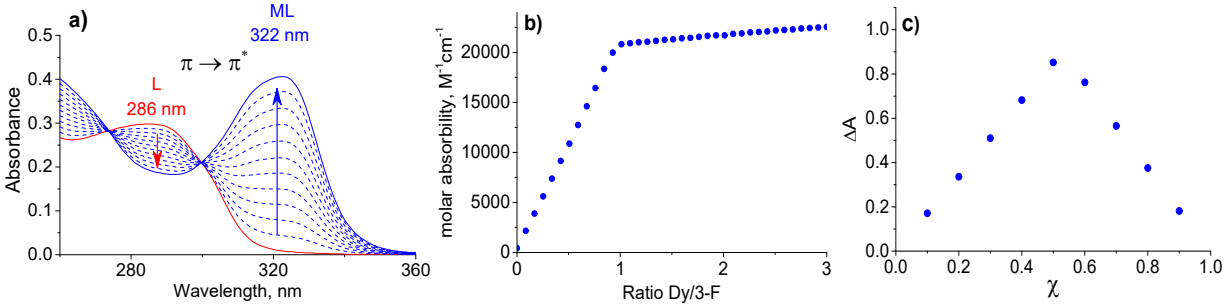
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.35 mM titrant solution $Gd(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $2.04 \cdot 10^{-2}$ mM 3-F: a) spectrophotometric data, where red line – 3-F spectrum, blue dashed lines – aliquots of $Gd(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Gd3\text{-}F](NO_3)_3$; b) titration curve at 322 nm; c) the method of continuous variation for 0,097 mM 3-F with 0,097 mM $Gd(NO_3)_3 \cdot 6H_2O$ at 322 nm.

3-F with $Tb(NO_3)_3 \cdot 5H_2O$



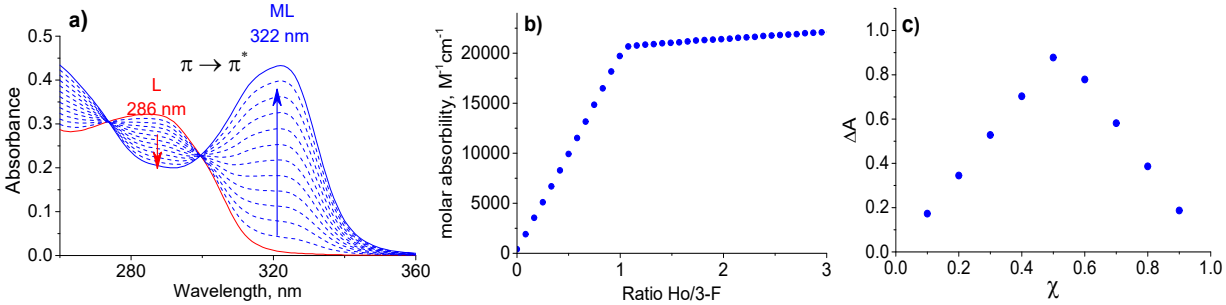
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.35 mM titrant solution $Tb(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $2.04 \cdot 10^{-2}$ mM 3-F: a) spectrophotometric data, where red line – 3-F spectrum, blue dashed lines – aliquots of $Tb(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Tb3\text{-}F](NO_3)_3$; b) titration curve at 322 nm; c) the method of continuous variation for 0,094 mM 3-F with 0,094 mM $Tb(NO_3)_3 \cdot 5H_2O$ at 322 nm.

3-F with $Dy(NO_3)_3 \cdot 5H_2O$



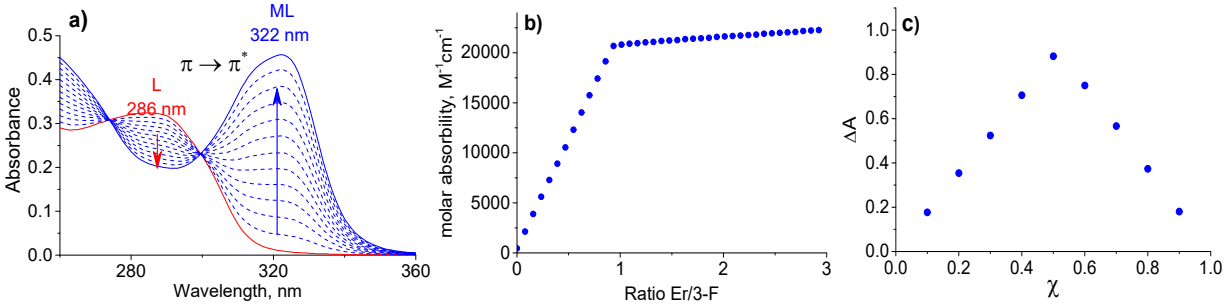
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.39 mM titrant solution $Dy(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $2.03 \cdot 10^{-2}$ mM 3-F: a) spectrophotometric data, where red line – 3-F spectrum, blue dashed lines – aliquots of $Dy(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Dy3\text{-}F](NO_3)_3$; b) titration curve at 322 nm; c) the method of continuous variation for 0,100 mM 3-F with 0,100 mM $Dy(NO_3)_3 \cdot 5H_2O$ at 322 nm.

3-F with $Ho(NO_3)_3 \cdot 5H_2O$



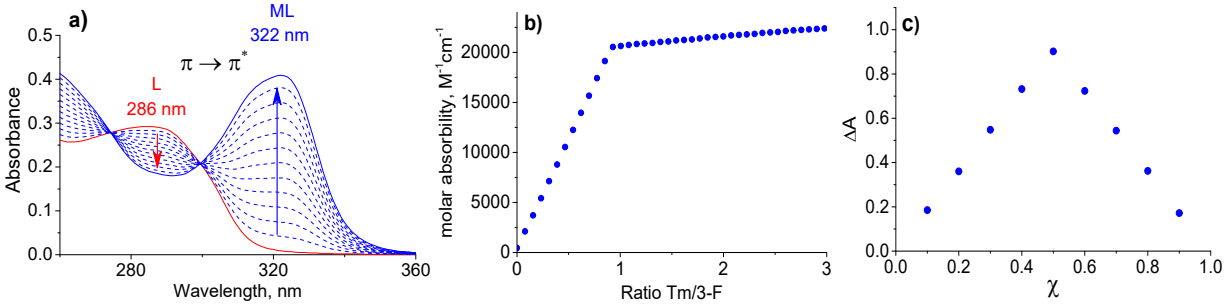
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.34 mM titrant solution $Ho(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $2.19 \cdot 10^{-2}$ mM 3-F: a) spectrophotometric data, where red line – 3-F spectrum, blue dashed lines – aliquots of $Ho(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Ho3\text{-}F](NO_3)_3$; b) titration curve at 322 nm; c) the method of continuous variation for 0,106 mM 3-F with 0,106 mM $Ho(NO_3)_3 \cdot 5H_2O$ at 322 nm.

3-F with $Er(NO_3)_3 \cdot 5H_2O$



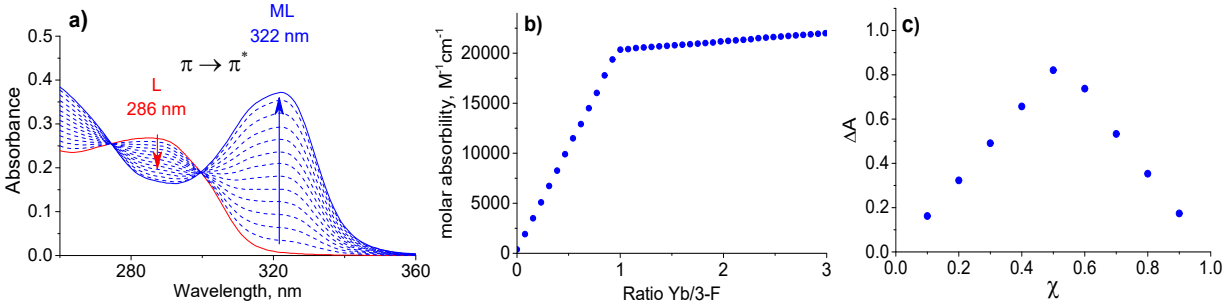
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.46 mM titrant solution $Er(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $2.21 \cdot 10^{-2}$ mM 3-F: a) spectrophotometric data, where red line – 3-F spectrum, blue dashed lines – aliquots of $Er(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Er3\text{-}F](NO_3)_3$; b) titration curve at 322 nm; c) the method of continuous variation for 0,107 mM 3-F with 0,106 mM $Er(NO_3)_3 \cdot 5H_2O$ at 322 nm.

3-F with $Tm(NO_3)_3 \cdot 5H_2O$



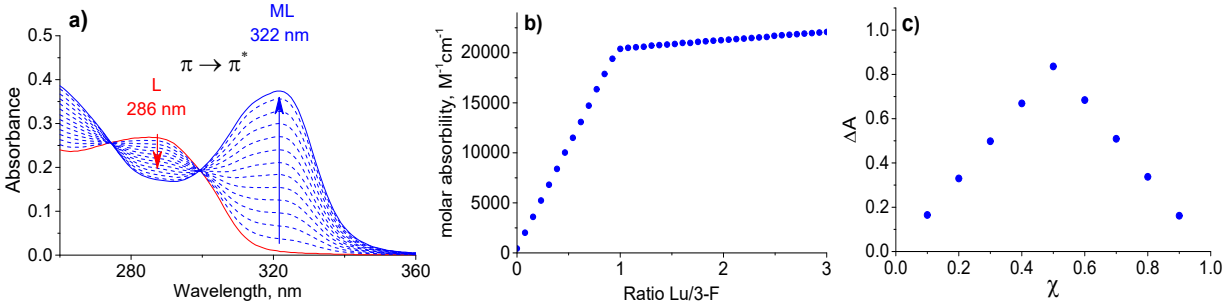
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.11 mM titrant solution $Tm(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $1.99 \cdot 10^{-2}$ mM 3-F: a) spectrophotometric data, where red line – 3-F spectrum, blue dashed lines – aliquots of $Tm(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Tm3\text{-}F](NO_3)_3$; b) titration curve at 322 nm; c) the method of continuous variation for 0,110 mM 3-F with 0,110 mM $Tm(NO_3)_3 \cdot 5H_2O$ at 322 nm.

3-F with $Yb(NO_3)_3 \cdot 5H_2O$



Spectrophotometric titration in "dry" CH_3CN solution: 2.316 µl of 1.23 mM titrant solution $Yb(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $1.83 \cdot 10^{-2}$ mM 3-F: a) spectrophotometric data, where red line – 3-F spectrum, blue dashed lines – aliquots of $Yb(NO_3)_3 \cdot 5H_2O$ and blue line – complex [Yb3-F]$(NO_3)_3$; b) titration curve at 322 nm; c) the method of continuous variation for 0,101 mM 3-F with 0,101 mM $Yb(NO_3)_3 \cdot 5H_2O$ at 322 nm.

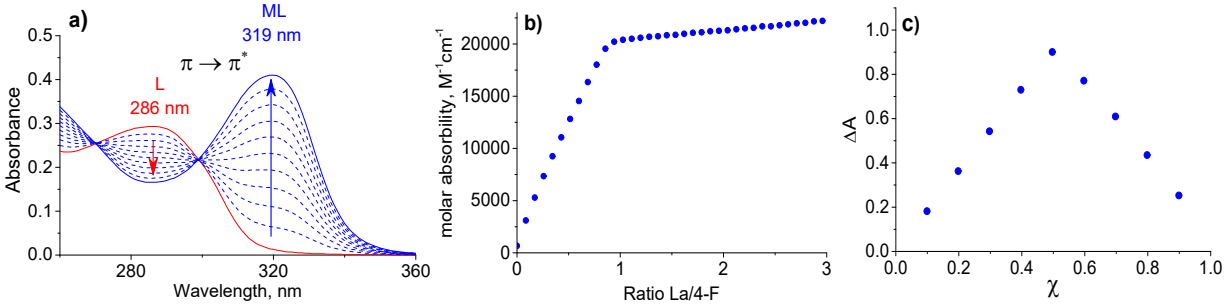
3-F with $Lu(NO_3)_3 \cdot 4H_2O$



Spectrophotometric titration in "dry" CH_3CN solution: 1.91 µl of 1.49 mM titrant solution $Lu(NO_3)_3 \cdot 4H_2O$ was added to 2 ml of $1.83 \cdot 10^{-2}$ mM 3-F: a) spectrophotometric data, where red line – 3-F spectrum, blue dashed lines – aliquots of $Lu(NO_3)_3 \cdot 4H_2O$ and blue line – complex [Lu3-F]$(NO_3)_3$; b) titration curve at 322 nm; c) the method of continuous variation for 0,099 mM 3-F with 0,099 mM $Lu(NO_3)_3 \cdot 4H_2O$ at 322 nm.

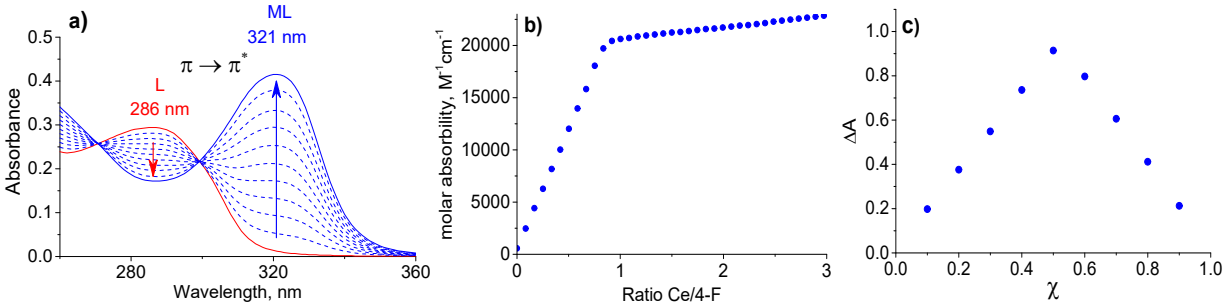
4-F ligand with trivalent lanthanide ions

4-F with $La(NO_3)_3 \cdot 6H_2O$



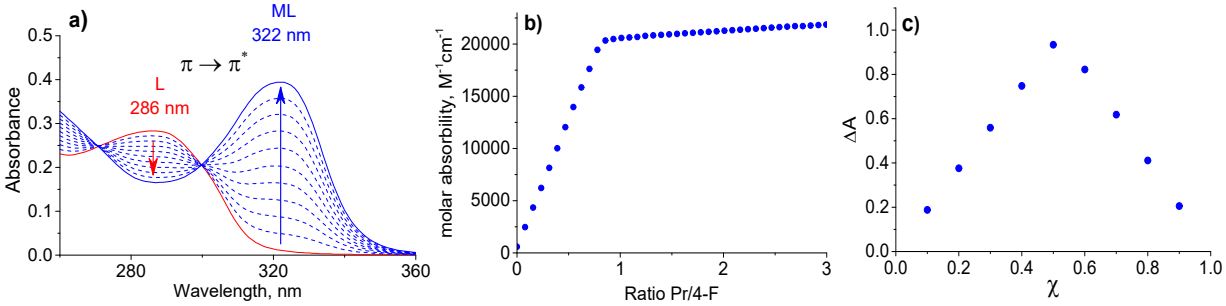
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.44 mM titrant solution $La(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $2.10 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $La(NO_3)_3 \cdot 6H_2O$ and blue line – complex [La4-F]$(NO_3)_3$; b) titration curve at 319 nm; c) the method of continuous variation for 0,110 mM 4-F with 0,112 mM $La(NO_3)_3 \cdot 6H_2O$ at 319 nm.

4-F with $Ce(NO_3)_3 \cdot 6H_2O$



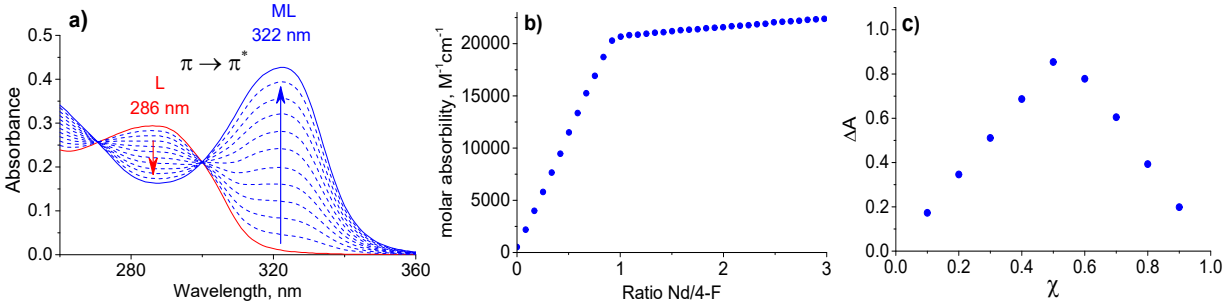
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.36 mM titrant solution $Ce(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $2.10 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Ce(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Ce4\text{-}F](NO_3)_3$; b) titration curve at 321 nm; c) the method of continuous variation for 0,110 mM 4-F with 0,110 mM $Ce(NO_3)_3 \cdot 6H_2O$ at 321 nm.

4-F with $Pr(NO_3)_3 \cdot 6H_2O$



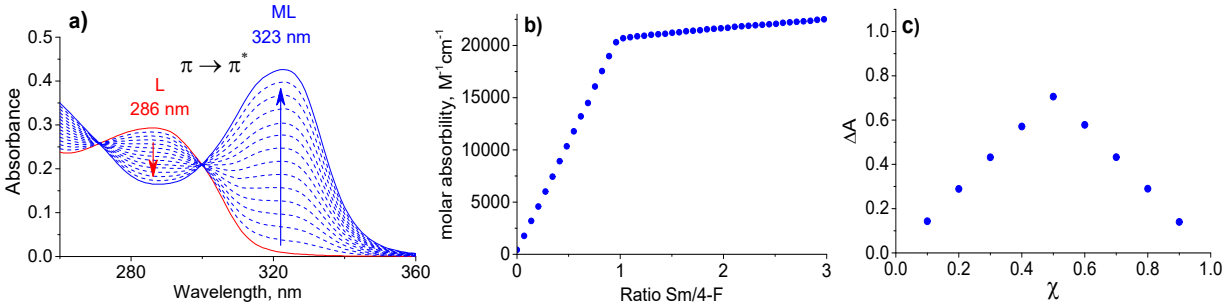
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.13 mM titrant solution $Pr(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $2.03 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Pr(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Pr4\text{-}F](NO_3)_3$; b) titration curve at 322 nm; c) the method of continuous variation for 0,111 mM 4-F with 0,111 mM $Pr(NO_3)_3 \cdot 6H_2O$ at 322 nm.

4-F with $Nd(NO_3)_3 \cdot 6H_2O$



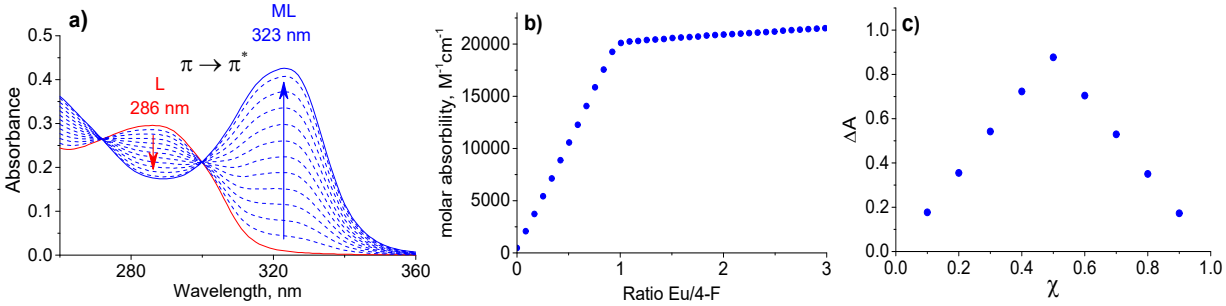
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.37 mM titrant solution $Nd(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $2.10 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Nd(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Nd4\text{-}F](NO_3)_3$; b) titration curve at 322 nm; c) the method of continuous variation for 0,102 mM 4-F with 0,102 mM $Nd(NO_3)_3 \cdot 6H_2O$ at 322 nm.

4-F with $Sm(NO_3)_3 \cdot 6H_2O$



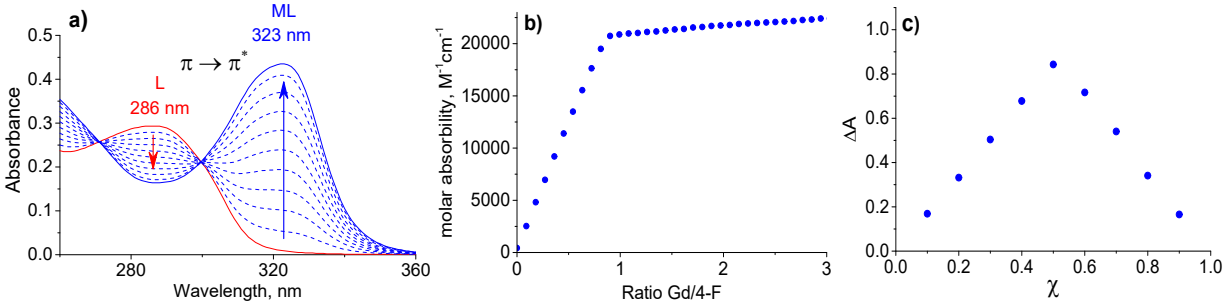
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 2.76 mM titrant solution $Sm(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $2.10 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Sm(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Sm4\text{-}F](NO_3)_3$; b) titration curve at 323 nm; c) the method of continuous variation for 0,086 mM 4-F with 0,086 mM $Sm(NO_3)_3 \cdot 6H_2O$ at 323 nm.

4-F with $Eu(NO_3)_3 \cdot 6H_2O$



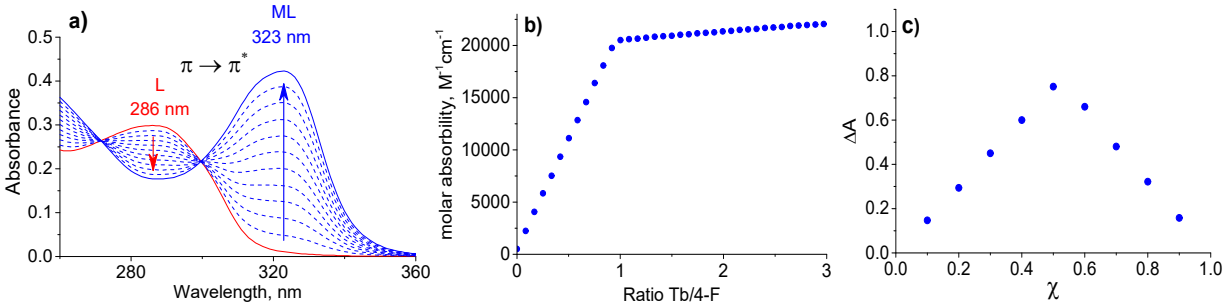
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.38 mM titrant solution $Eu(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $2.12 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Eu(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Eu4\text{-}F](NO_3)_3$; b) titration curve at 323 nm; c) the method of continuous variation for 0,108 mM 4-F with 0,108 mM $Eu(NO_3)_3 \cdot 6H_2O$ at 323 nm.

4-F with $Gd(NO_3)_3 \cdot 6H_2O$



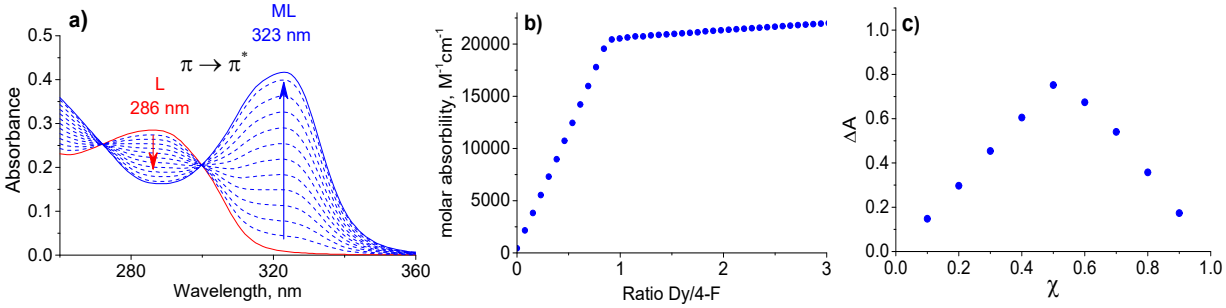
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.62 mM titrant solution $Gd(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $2.10 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Gd(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Gd4\text{-}F](NO_3)_3$; b) titration curve at 323 nm; c) the method of continuous variation for 0,100 mM 4-F with 0,100 mM $Gd(NO_3)_3 \cdot 6H_2O$ at 323 nm.

4-F with $Tb(NO_3)_3 \cdot 5H_2O$



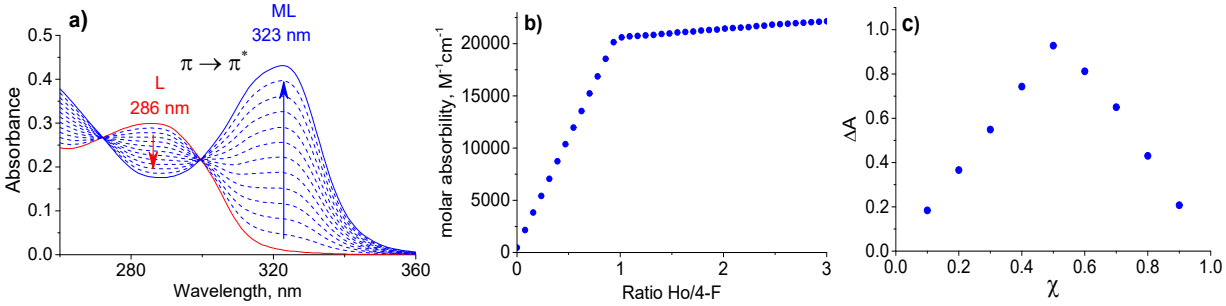
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.36 mM titrant solution $Tb(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $2.14 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Tb(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Tb4\text{-}F](NO_3)_3$; b) titration curve at 323 nm; c) the method of continuous variation for 0,091 mM 4-F with 0,091 mM $Tb(NO_3)_3 \cdot 5H_2O$ at 323 nm.

4-F with $Dy(NO_3)_3 \cdot 5H_2O$



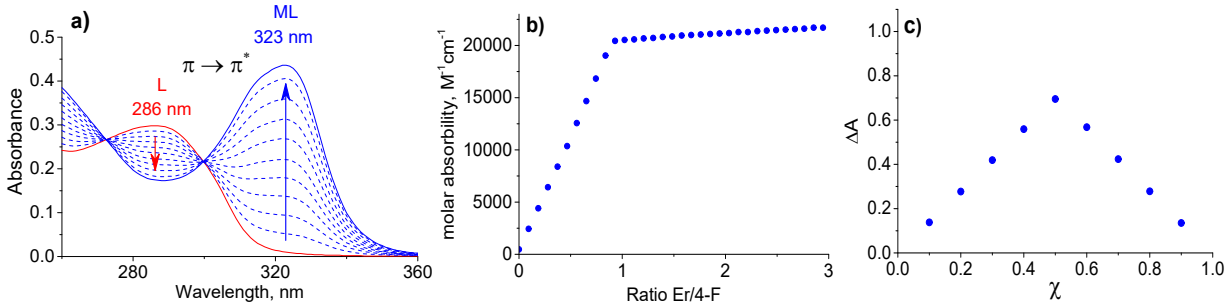
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.08 mM titrant solution $Dy(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $2.04 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Dy(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Dy4\text{-}F](NO_3)_3$; b) titration curve at 323 nm; c) the method of continuous variation for 0,091 mM 4-F with 0,091 mM $Dy(NO_3)_3 \cdot 5H_2O$ at 323 nm.

4-F with $Ho(NO_3)_3 \cdot 5H_2O$



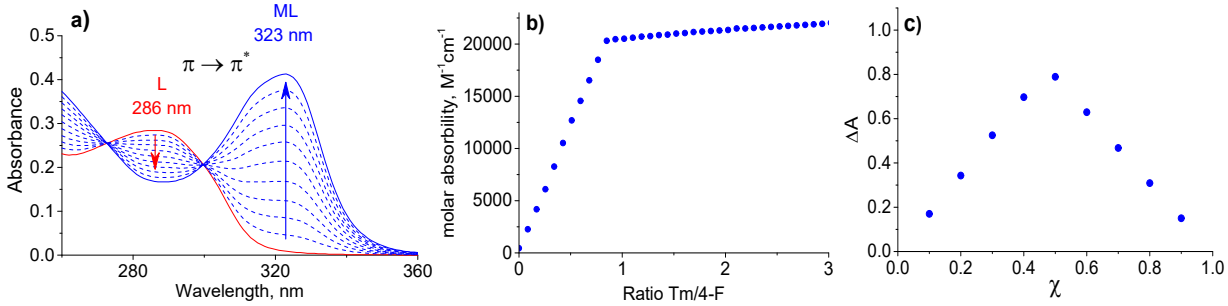
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.14 mM titrant solution $Ho(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $2.14 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Ho(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Ho4\text{-}F](NO_3)_3$; b) titration curve at 323 nm; c) the method of continuous variation for 0,110 mM 4-F with 0,110 mM $Ho(NO_3)_3 \cdot 5H_2O$ at 323 nm.

4-F with $Er(NO_3)_3 \cdot 5H_2O$



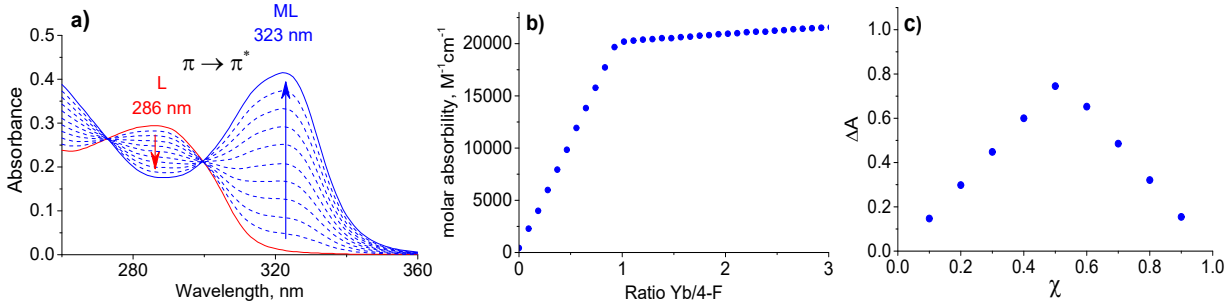
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.74 mM titrant solution $Er(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $2.13 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Er(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Er4\text{-}F](NO_3)_3$; b) titration curve at 323 nm; c) the method of continuous variation for 0,083 mM 4-F with 0,083 mM $Er(NO_3)_3 \cdot 5H_2O$ at 323 nm.

4-F with $Tm(NO_3)_3 \cdot 5H_2O$



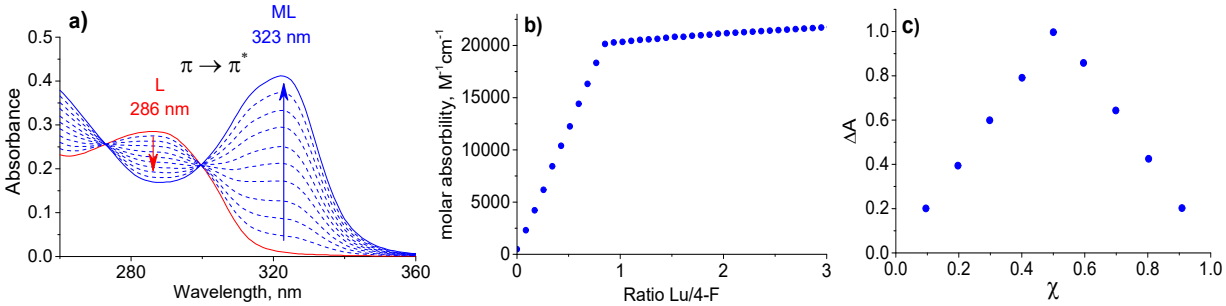
Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.41 mM titrant solution $Tm(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $2.03 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Tm(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Tm4\text{-}F](NO_3)_3$; b) titration curve at 323 nm; c) the method of continuous variation for 0,107 mM 4-F with 0,107 mM $Tm(NO_3)_3 \cdot 5H_2O$ at 323 nm.

4-F with $Yb(NO_3)_3 \cdot 5H_2O$



Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.72 mM titrant solution $Yb(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $2.10 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Yb(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Yb4\text{-}F](NO_3)_3$; b) titration curve at 323 nm; c) the method of continuous variation for 0,093 mM 4-F with 0,093 mM $Yb(NO_3)_3 \cdot 5H_2O$ at 323 nm.

4-F with $Lu(NO_3)_3 \cdot 4H_2O$

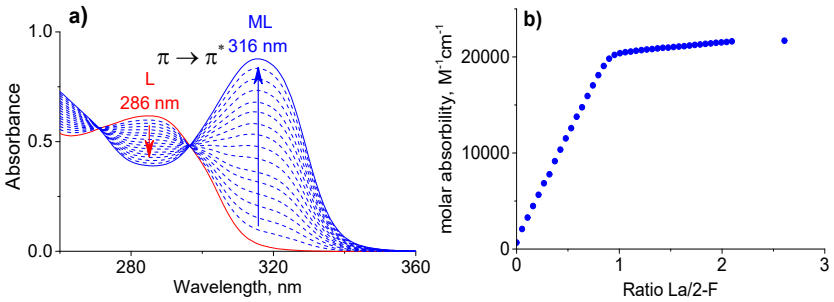


Spectrophotometric titration in "dry" CH_3CN solution: 1 µl of 3.42 mM titrant solution $Lu(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $2.04 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Lu(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Lu4\text{-}F](NO_3)_3$; b) titration curve at 323 nm; c) the method of continuous variation for 0,113 mM 4-F with 0,122 mM $Lu(NO_3)_3 \cdot 5H_2O$ at 323 nm.

UV-vis Titration Data in "wet" CH_3CN

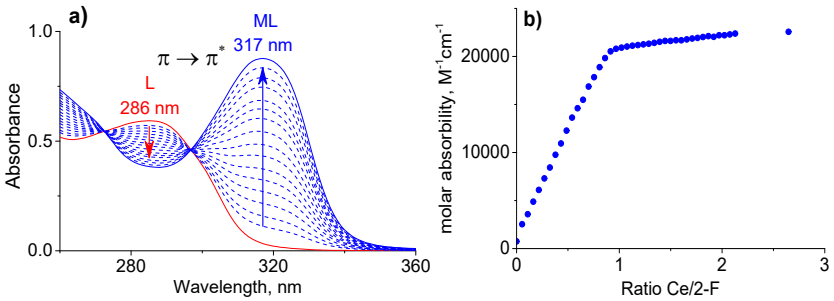
2-F ligand with trivalent lanthanide ions

2-F with $La(NO_3)_3 \cdot 6H_2O$



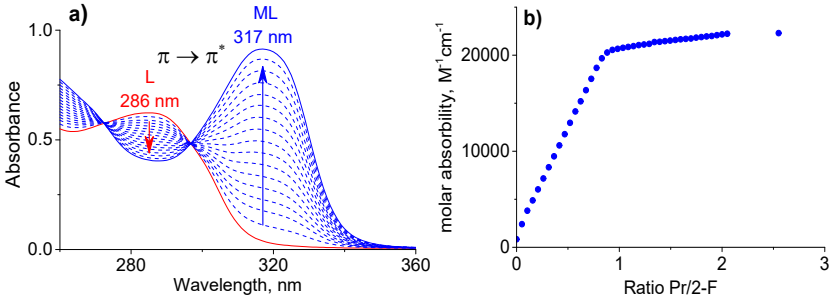
Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 4.58 mM titrant solution $La(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $4.60 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $La(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[La2\text{-}F](NO_3)_3$; b) titration curve at 316 nm.

2-F with $Ce(NO_3)_3 \cdot 6H_2O$



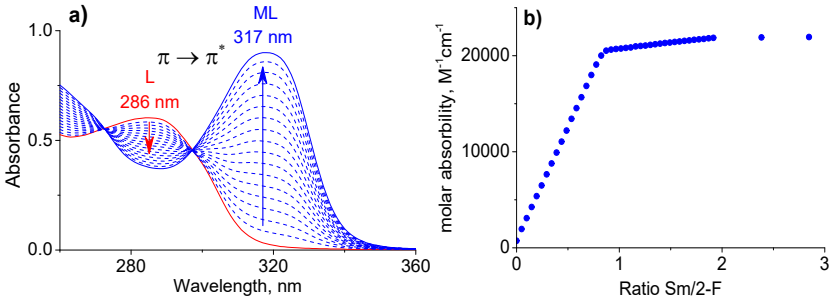
Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 4.65 mM titrant solution $Ce(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $4.42 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Ce(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Ce2\text{-}F](NO_3)_3$; b) titration curve at 317 nm.

2-F with $Pr(NO_3)_3 \cdot 6H_2O$



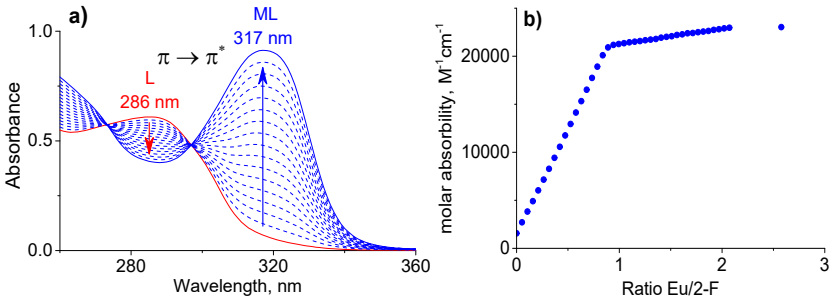
Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 4.48 mM titrant solution $Pr(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $4.65 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Pr(NO_3)_3 \cdot 6H_2O$ and blue line – complex [Pr2-F]$(NO_3)_3$; b) titration curve at 317 nm.

2-F with $Sm(NO_3)_3 \cdot 6H_2O$



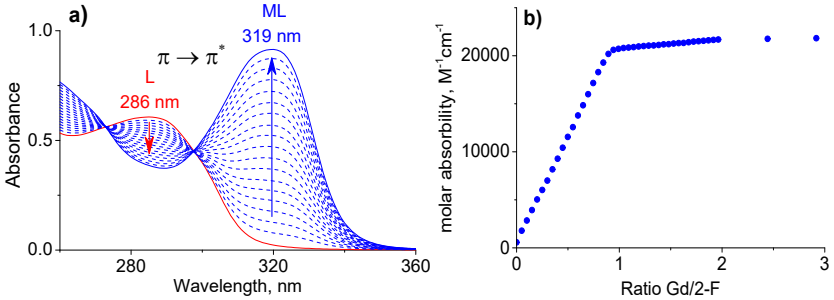
Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 4.18 mM titrant solution $Sm(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $4.50 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Sm(NO_3)_3 \cdot 6H_2O$ and blue line – complex [Sm2-F]$(NO_3)_3$; b) titration curve at 317 nm.

2-F with $Eu(NO_3)_3 \cdot 6H_2O$



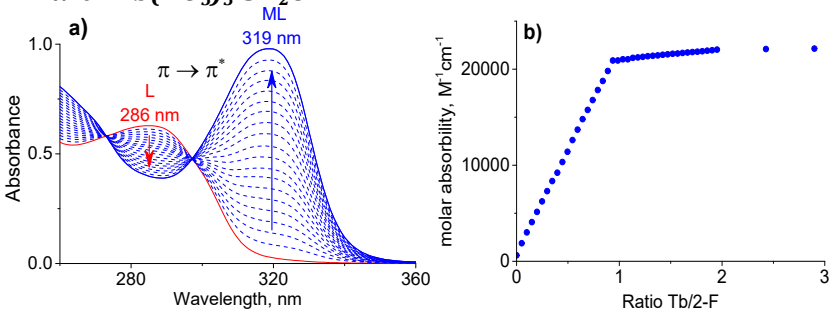
Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 4.52 mM titrant solution $Eu(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $4.54 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Eu(NO_3)_3 \cdot 6H_2O$ and blue line – complex [Eu2-F]$(NO_3)_3$; b) titration curve at 317 nm.

2-F with $Gd(NO_3)_3 \cdot 6H_2O$



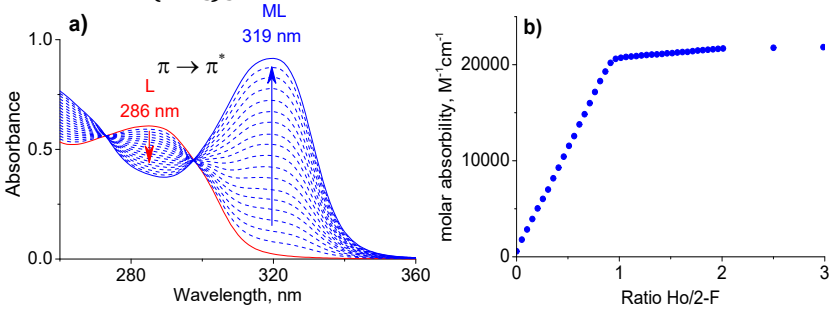
Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 4.29 mM titrant solution $Gd(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $4.53 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Gd(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Gd2\text{-}F](NO_3)_3$; b) titration curve at 319 nm.

2-F with $Tb(NO_3)_3 \cdot 5H_2O$



Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 4.26 mM titrant solution $Tb(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $4.68 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Tb(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Tb2\text{-}F](NO_3)_3$; b) titration curve at 319 nm.

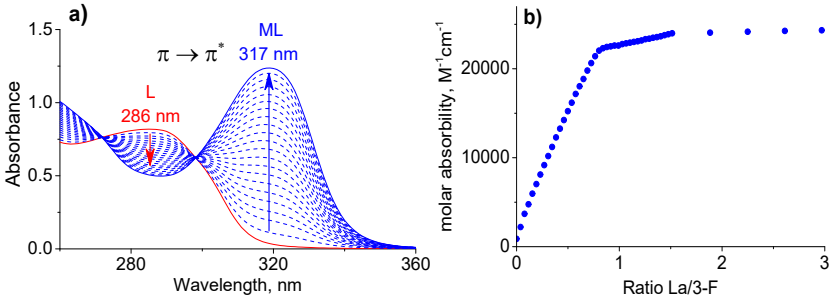
2-F with $Ho(NO_3)_3 \cdot 5H_2O$



Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 4.39 mM titrant solution $Ho(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $4.53 \cdot 10^{-2}$ mM 2-F: a) spectrophotometric data, where red line – 2-F spectrum, blue dashed lines – aliquots of $Ho(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Ho2\text{-}F](NO_3)_3$; b) titration curve at 319 nm.

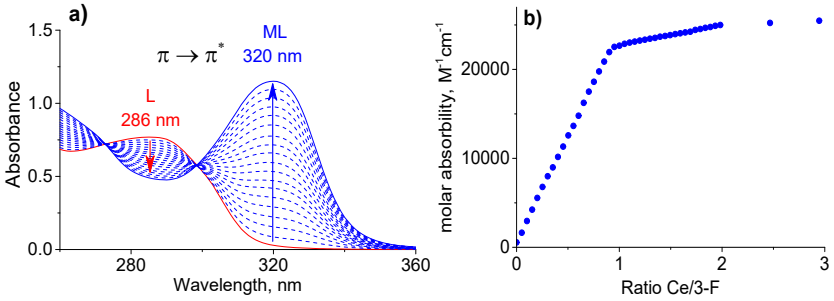
3-F ligand with trivalent lanthanide ions

3-F with $La(NO_3)_3 \cdot 6H_2O$



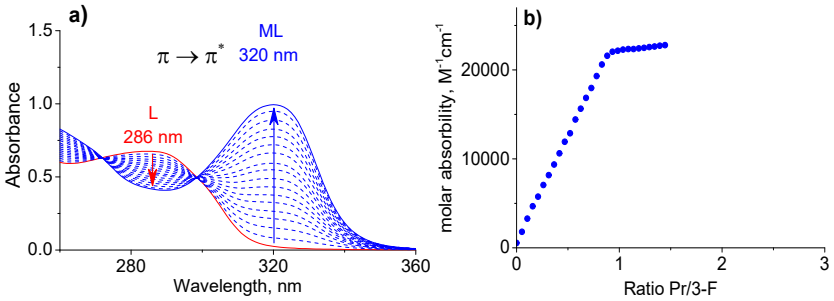
Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 4.31 mM titrant solution $La(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $5.59 \cdot 10^{-2}$ mM 3-F: a) spectrophotometric data, where red line – 3-F spectrum, blue dashed lines – aliquots of $La(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[La3\text{-}F](NO_3)_3$; b) titration curve at 317 nm.

3-F with $Ce(NO_3)_3 \cdot 6H_2O$



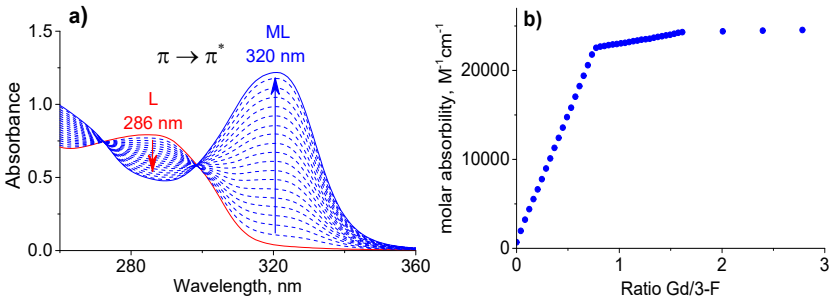
Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 4.36 mM titrant solution $Ce(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $5.24 \cdot 10^{-2}$ mM 3-F: a) spectrophotometric data, where red line – 3-F spectrum, blue dashed lines – aliquots of $Ce(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Ce3\text{-}F](NO_3)_3$; b) titration curve at 320 nm.

3-F with $Pr(NO_3)_3 \cdot 6H_2O$



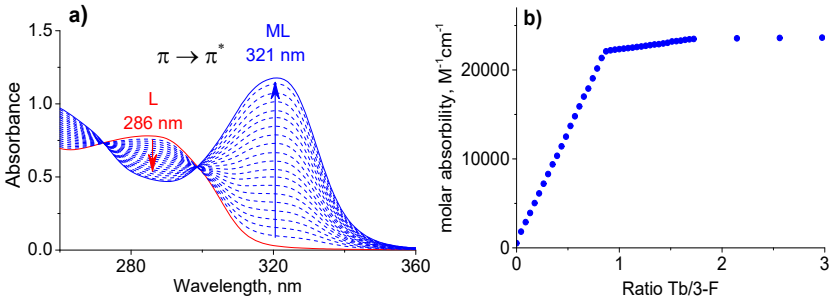
Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 4.84 mM titrant solution $Pr(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $4.60 \cdot 10^{-2}$ mM 3-F: a) spectrophotometric data, where red line – 3-F spectrum, blue dashed lines – aliquots of $Pr(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Pr3\text{-}F](NO_3)_3$; b) titration curve at 320 nm.

3-F with $Gd(NO_3)_3 \cdot 6H_2O$



Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 4.44 mM titrant solution $Gd(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $5.40 \cdot 10^{-2}$ mM 3-F: a) spectrophotometric data, where red line – 3-F spectrum, blue dashed lines – aliquots of $Gd(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Gd3\text{-}F](NO_3)_3$; b) titration curve at 320 nm.

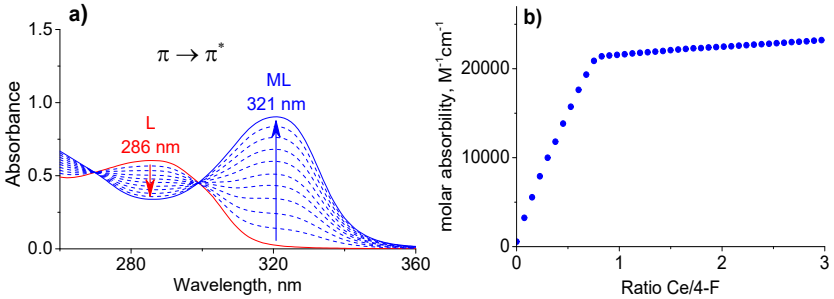
3-F with $Tb(NO_3)_3 \cdot 5H_2O$



Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 4.68 mM titrant solution $Tb(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $5.33 \cdot 10^{-2}$ mM 3-F: a) spectrophotometric data, where red line – 3-F spectrum, blue dashed lines – aliquots of $Tb(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Tb3\text{-}F](NO_3)_3$; b) titration curve at 321 nm.

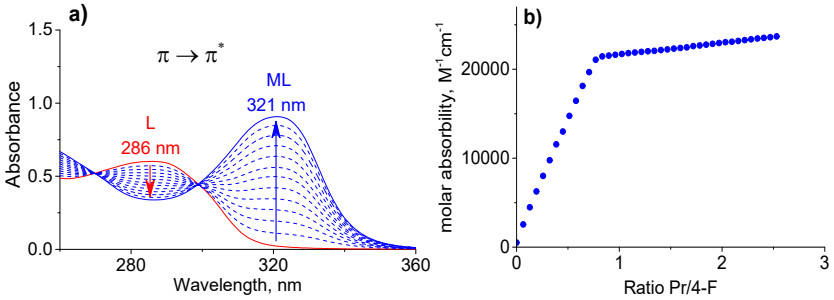
4-F ligand with trivalent lanthanide ions

4-F with $Ce(NO_3)_3 \cdot 6H_2O$



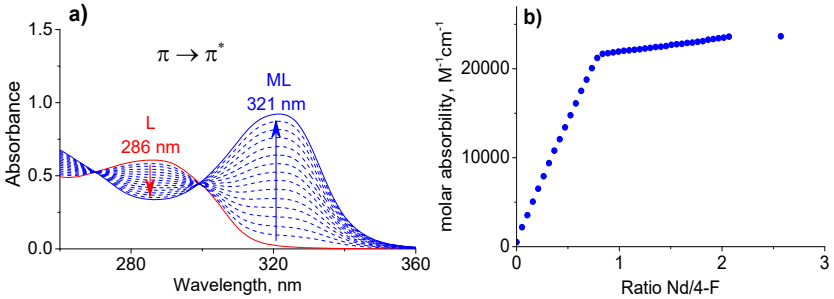
Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 6.54 mM titrant solution $Ce(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $4.32 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Ce(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Ce4\text{-}F](NO_3)_3$; b) titration curve at 321 nm.

4-F with $Pr(NO_3)_3 \cdot 6H_2O$



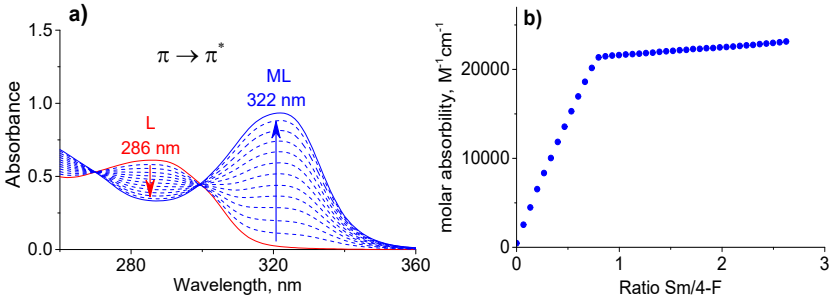
Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 5.56 mM titrant solution $Pr(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $4.31 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Pr(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Pr4\text{-}F](NO_3)_3$; b) titration curve at 321 nm.

4-F with $Nd(NO_3)_3 \cdot 6H_2O$



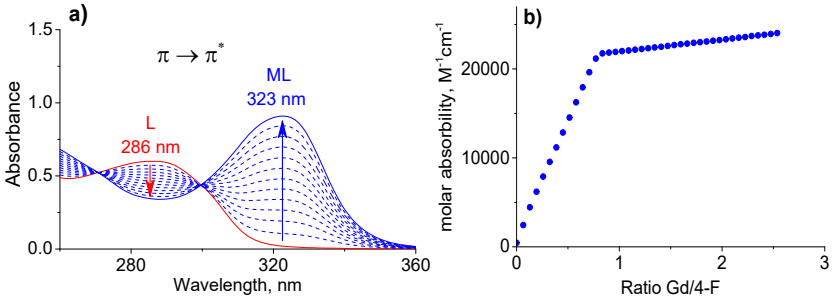
Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 4.58 mM titrant solution $Nd(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $4.34 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Nd(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Nd4\text{-}F](NO_3)_3$; b) titration curve at 321 nm.

4-F with $Sm(NO_3)_3 \cdot 6H_2O$



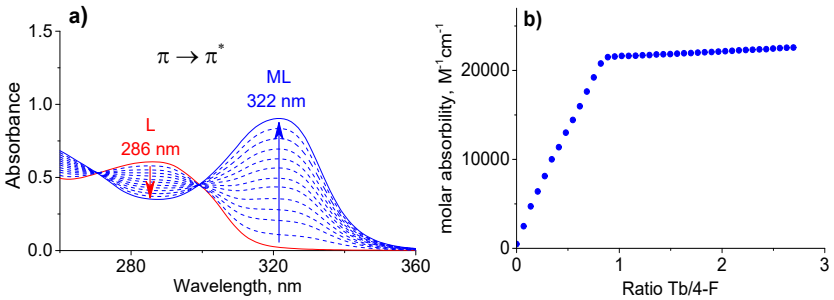
Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 5.85 mM titrant solution $Sm(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $4.37 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Sm(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Sm4\text{-}F](NO_3)_3$; b) titration curve at 322 nm.

4-F with $Gd(NO_3)_3 \cdot 6H_2O$



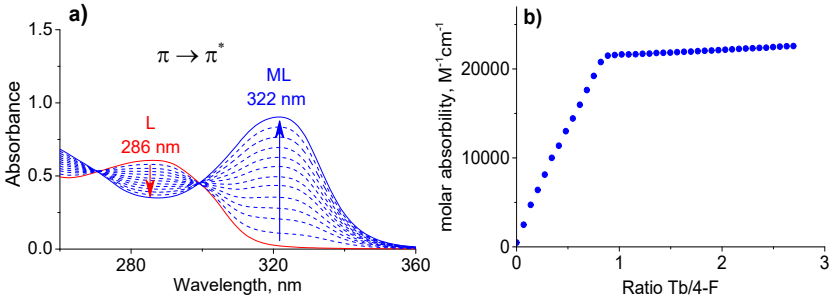
Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 5.56 mM titrant solution $Gd(NO_3)_3 \cdot 6H_2O$ was added to 2 ml of $4.29 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Gd(NO_3)_3 \cdot 6H_2O$ and blue line – complex $[Gd4\text{-}F](NO_3)_3$; b) titration curve at 323 nm.

4-F with $Tb(NO_3)_3 \cdot 5H_2O$



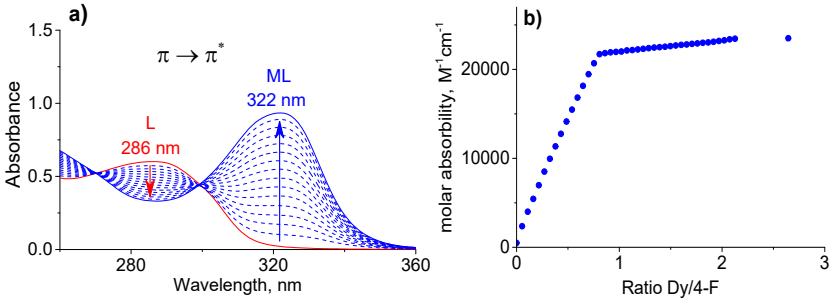
Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 5.97 mM titrant solution $Tb(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $4.34 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Tb(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Tb4\text{-}F](NO_3)_3$; b) titration curve at 322 nm.

4-F with $Tb(NO_3)_3 \cdot 5H_2O$



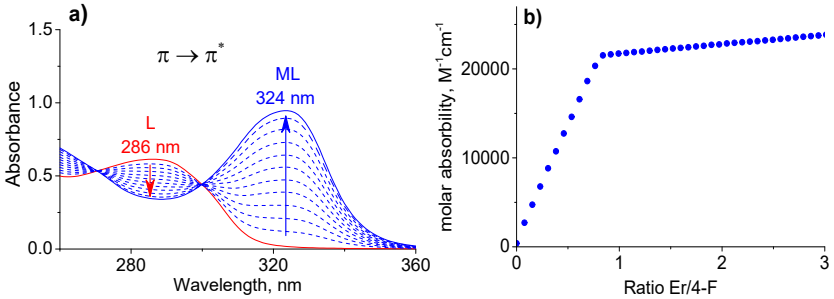
Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 5.97 mM titrant solution $Tb(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $4.34 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Tb(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Tb4\text{-}F](NO_3)_3$; b) titration curve at 322 nm.

4-F with $Dy(NO_3)_3 \cdot 5H_2O$



Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 4.66 mM titrant solution $Dy(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $4.30 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Dy(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Dy4\text{-}F](NO_3)_3$; b) titration curve at 322 nm.

4-F with $Er(NO_3)_3 \cdot 5H_2O$



Spectrophotometric titration in "wet" CH_3CN solution: 1 µl of 6.75 mM titrant solution $Er(NO_3)_3 \cdot 5H_2O$ was added to 2 ml of $4.39 \cdot 10^{-2}$ mM 4-F: a) spectrophotometric data, where red line – 4-F spectrum, blue dashed lines – aliquots of $Er(NO_3)_3 \cdot 5H_2O$ and blue line – complex $[Er4\text{-}F](NO_3)_3$; b) titration curve at 324 nm.