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Supplementary Material

Halogen bonding in drug-like molecules: A computational and systematic study of the substituent effect

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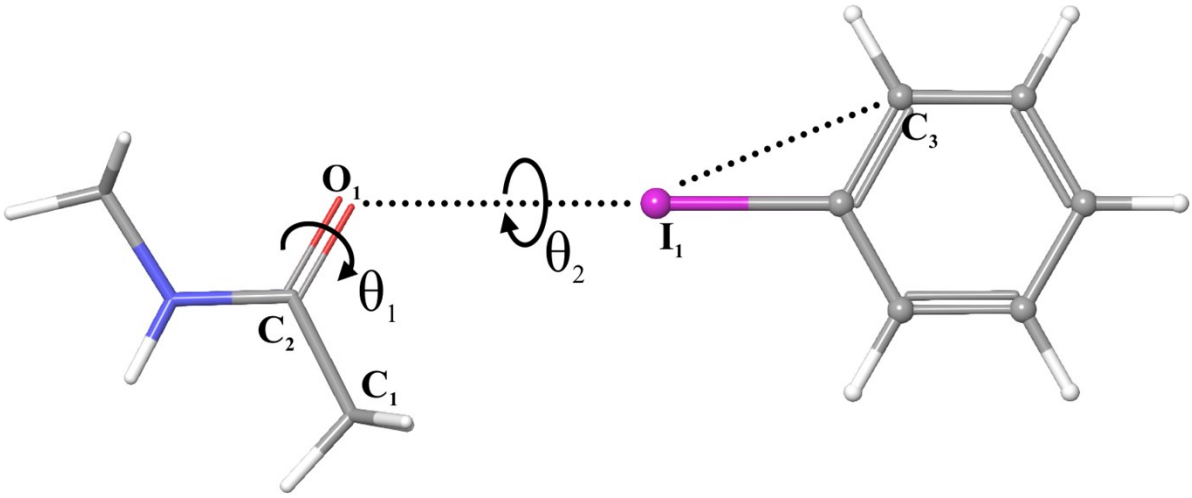

Figure S1 Representation of the starting geometry in iodobenzene···NMA complex (top view). Dihedral harmonic constraints are indicated as θ_1 (C_1–C_2–O_1···I_1) and θ_2 (C_2–O_1···I_1–C_3)

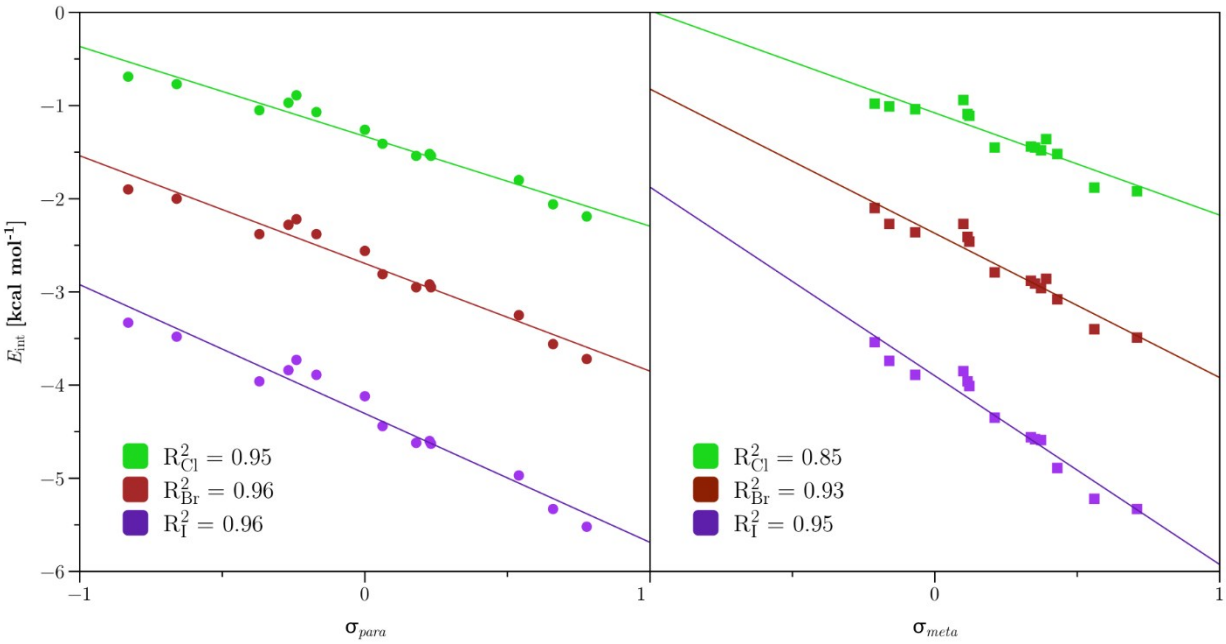

Figure S2 Hammett's plots of *para*- (left) and *meta*-substituted (right) halobenzene···NMA complexes. Data is color-coded by halogen: chlorine (green), bromine (dark red) and iodine (violet).

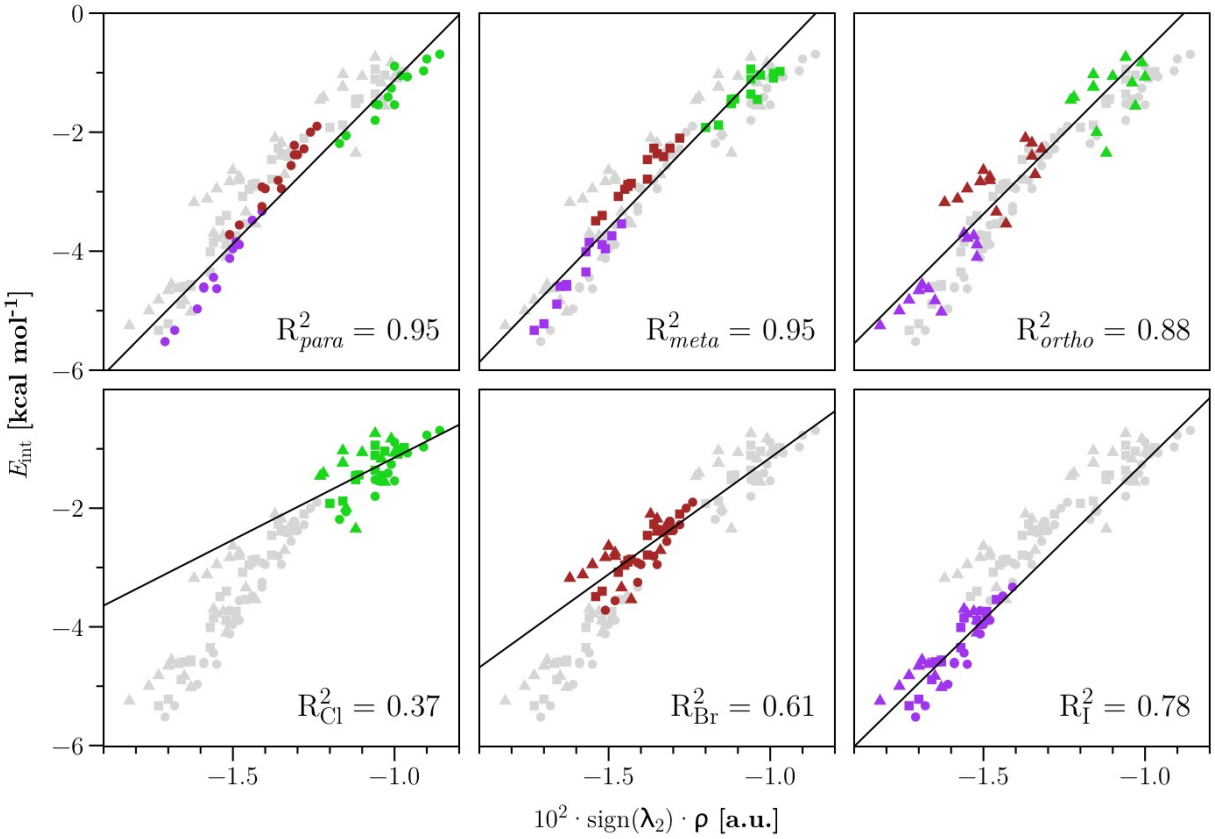

Figure S3 Regression plots of the electron density at the X···O bond CP *versus* the interaction energies per substitution position (top) and per halogen atom (bottom). Data points are coded by halogen: chlorine (green), bromine (dark red) and iodine (violet), and by substitution position: *para* (circle, ●), *meta* (square, ■) and *ortho* (triangle, ▲).

Table S1 Substituent frequency on the halobenzene moiety in the ZINC database.[a] Relative frequencies are given with respect to the total number of substituents found at the corresponding position.

R'	***ortho***	**%**	***meta***	**%**	***para***	**%**
Br	23,589	1.7	91,168	5.2	30,680	4.0
CF_3	17,836	1.3	9,446	0.5	12,333	1.6
CH_3	55,148	4.0	33,845	1.9	11,960	1.6
Cl	291,549	20.9	454,634	25.9	106,243	14.0
CN	19,926	1.4	15,772	0.9	13,560	1.8
F	529,077	38.0	781,660	44.5	218,345	28.7
I	2,283	0.2	4,703	0.3	1,785	0.2
$N(CH_3)_2$	4,171	0.3	1,116	0.1	1,681	0.2
NH_2	18,573	1.3	26,044	1.5	18,565	2.4
$NHCOCH_3$	8,706	0.6	3,265	0.2	8,208	1.1
NO_2	34,516	2.5	47,072	2.7	31,182	4.1
$O(CH_3)_2$	20,200	1.5	12,067	0.7	10,145	1.3
OCH_3	130,154	9.3	79,354	4.5	112,158	14.7
OH	32,131	2.3	18,315	1.0	35,270	4.6
4-fluorophenyl	8	0.0	349	0.0	8,852	1.2
Accum	1,187,867	85.3	1,578,810	89.9	620,967	81.6
Totals	1,393,028	35.6[b]	1,755,410	44.9[b]	760,682	19.5[b]

[a] Note that only chemical groups with less than 8 heavy atoms and with at least 1% of occurrence in one or more of the three substitution positions are included, except I and $N(CH_3)_2$.

[b] Percentage relative to the total amount of found substituents (i.e., 3,909,120).

Table S2 Energetic values, geometric features and molecular properties of un- and substituted chlorobenzene···NMA complexes[a]

R'	E_{int}	ΔE_{int}	R_e	α_{donor}	α_{acc}	$10^2 \times \rho$	$10^{-1} \times V_{S,max}$	$10^2 \times$ CT
H	−1.19 (−0.92)		3.02	177.9	112.9	−1.01	0.55	0.38
*p*Br	−1.54 (−1.31)	−0.35	3.02	179.6	114.2	−1.00	0.92	0.42
pCF_3	−1.80 (−1.22)	−0.61	2.99	177.3	113.8	−1.06	1.21	0.43
pCH_3	−1.07 (−0.82)	+0.12	3.04	178.5	112.8	−0.96	0.42	0.35
*p*Cl	−1.52 (−1.28)	−0.33	2.99	178.4	114.1	−1.06	0.92	0.44
*p*CN	−2.06 (−1.75)	−0.87	2.95	179.3	116.8	−1.15	1.47	0.54
*p*F	−1.41 (−1.15)	−0.22	3.01	179.3	113.7	−1.02	0.82	0.40
*p*I	−1.54 (−1.23)	−0.35	2.99	178.6	114.1	−1.05	0.92	0.44
p$N(CH_3)_2$	−0.69 (−0.32)	+0.50	3.10	172.7	110.2	−0.86	0.00	0.21
pNH_2	−0.77 (−0.49)	+0.42	3.07	178.8	111.6	−0.90	0.08	0.28
p$NHCOCH_3$	−1.26 (−0.86)	−0.07	3.02	178.9	113.1	−1.01	0.48	0.37
pNO_2	−2.19 (−1.86)	−1.00	2.94	179.6	117.3	−1.17	1.59	0.54
pOCH_3	−0.97 (−0.71)	+0.22	3.07	172.6	110.8	−0.91	0.39	0.26
*p*O(CH3)$_2$	−0.89 (−0.66)	+0.30	3.01	177.4	116.8	−1.00	0.34	0.37
*p*OH	−1.05 (−0.83)	+0.14	3.03	178.8	113.6	−0.98	0.48	0.37
*m*Br	−1.36 (−0.94)	−0.17	2.97	177.3	126.3	−1.06	0.93	0.47
mCF_3	−1.52 (−1.21)	−0.33	2.94	177.4	127.8	−1.12	1.14	0.49
mCH_3	−1.04 (−0.77)	+0.15	3.00	178.6	117.0	−1.03	0.44	0.41
*m*Cl	−1.48 (−1.20)	−0.29	2.96	178.3	119.0	−1.12	0.96	0.50
*m*CN	−1.88 (−1.66)	−0.69	2.94	178.8	120.4	−1.16	1.39	0.56
*m*F	−1.44 (−1.24)	−0.25	2.96	178.1	120.0	−1.11	0.92	0.49
*m*I	−1.45 (−0.97)	−0.26	2.96	177.9	120.0	−1.12	0.92	0.50
m$N(CH_3)_2$	−0.98 (−0.63)	+0.21	3.04	178.6	112.8	−0.97	0.21	0.33
mNH_2	−1.01 (−0.71)	+0.18	3.03	179.4	114.0	−0.99	0.25	0.36
m$NHCOCH_3$	−1.45 (−1.17)	−0.26	3.00	179.1	113.9	−1.04	0.71	0.42
mNO_2	−1.92 (−1.62)	−0.73	2.92	179.0	120.7	−1.20	1.46	0.58
mOCH_3	−1.09 (−0.82)	+0.10	3.03	179.5	113.0	−0.99	0.43	0.37
*m*O(CH3)$_2$	−0.94 (−0.65)	+0.25	2.98	177.0	118.5	−1.06	0.40	0.43
*m*OH	−1.11 (−0.88)	+0.08	2.99	178.1	117.1	−1.06	0.55	0.43
*o*Br	−1.03 (−0.79)	+0.16	2.92	176.1	128.7	−1.16	0.83	0.52
oCF_3	−1.06 (−0.69)	+0.13	2.93	177.4	138.1	−1.10	1.00	0.44
oCH_3	−1.17 (−0.81)	+0.02	3.00	177.6	115.8	−1.04	0.49	0.42
*o*Cl	−1.24 (−0.94)	−0.05	2.94	179.1	119.6	−1.16	0.84	0.53
*o*CN	−1.41 (−1.11)	−0.22	2.90	178.0	126.8	−1.22	1.19	0.60
*o*F	−1.24 (−0.93)	−0.05	2.94	179.2	120.5	−1.16	0.85	0.52
*o*I	−1.24 (−0.76)	−0.05	2.94	179.6	119.6	−1.16	0.83	0.53
o$N(CH_3)_2$	−1.07 (−0.67)	+0.12	3.02	175.2	114.9	−1.00	0.37	0.39
oNH_2	−1.56 (−1.31)	−0.37	3.01	174.9	113.8	−1.03	0.63	0.41
o$NHCOCH_3$	−2.35 (−2.05)	−1.16	2.97	173.9	114.5	−1.12	1.33	0.49
oNO_2	−1.46 (−1.15)	−0.27	2.89	176.9	131.4	−1.23	1.28	0.60

oOCH_3	−0.83 (−0.54)	+0.36	3.01	176.5	113.7	−1.01	0.25	0.37
o$O(CH3)_2$	−0.74 (−0.42)	+0.45	2.98	179.7	116.6	−1.06	0.23	0.41
*o*OH	−2.00 (−1.71)	−0.81	2.94	172.0	122.2	−1.15	1.21	0.52

[a] Interaction energies (E_{int}) and energy differences with respect to the unsubstituted complex (ΔE_{int}) are in kcal mol^{-1}. Interaction energies were also calculated at the M06-2X/aug-pVTZ-PP level of theory (in parenthesis). Geometries features are equilibrium distances (R_e, Å), and donor (O···I–C, α_{donor}) and acceptor (C–O···I, α_{acc}) angles. Molecular properties are the electron density at the Cl···O bond CP ($sign(\lambda_2) \cdot \rho$, a.u.), the most positive MEP value on the halogen atom ($V_{S,max}$, kcal mol^{-1}) and the charge transfer.

Table S3 Energetic values, geometric features and molecular properties of un- and substituted bromobenzene···NMA complexes[a]

R'	E_{int}	ΔE_{int}	R_e	α_{donor}	α_{acc}	$10^2 \times \rho$	$10^{-1} \times V_{S,max}$	$10^2 \times$ CT
H	−2.49 (−2.12)		2.95	178.8	117.0	−1.35	1.19	0.84
*p*Br	−2.95 (−2.47)	−0.46	2.95	178.9	117.7	−1.35	1.60	0.92
pCF_3	−3.25 (−2.73)	−0.76	2.93	178.2	116.8	−1.41	1.86	0.98
pCH_3	−2.38 (−1.97)	+0.11	2.97	178.5	116.5	−1.30	1.07	0.79
*p*Cl	−2.93 (−2.45)	−0.44	2.93	178.9	118.1	−1.41	1.58	0.96
*p*CN	−3.56 (−3.13)	−1.07	2.90	179.3	119.4	−1.48	2.08	1.08
*p*F	−2.81 (−2.40)	−0.32	2.95	179.3	117.5	−1.36	1.47	0.90
*p*I	−2.95 (−2.38)	−0.46	2.93	179.0	117.5	−1.40	1.58	0.95
p$N(CH_3)_2$	−1.90 (−1.52)	+0.59	3.00	179.8	116.2	−1.24	0.63	0.69
pNH_2	−2.00 (−1.63)	+0.49	2.99	178.8	115.8	−1.26	0.73	0.71
p$NHCOCH_3$	−2.56 (−2.15)	−0.07	2.97	178.2	115.9	−1.32	1.12	0.80
pNO_2	−3.72 (−3.30)	−1.23	2.89	179.3	119.3	−1.51	2.21	1.13
pOCH_3	−2.28 (−1.95)	+0.21	2.98	177.5	115.6	−1.28	1.03	0.75
p$O(CH3)_2$	−2.22 (−1.89)	+0.27	2.97	179.1	118.4	−1.31	1.00	0.81
*p*OH	−2.38 (−2.06)	+0.11	2.97	179.0	117.0	−1.31	1.13	0.81
*m*Br	−2.86 (−2.38)	−0.37	2.92	178.1	125.2	−1.43	1.60	0.98
mCF_3	−3.08 (−2.73)	−0.59	2.90	178.1	125.5	−1.47	1.79	1.03
mCH_3	−2.36 (−2.04)	+0.13	2.95	178.4	118.7	−1.35	1.07	0.84
*m*Cl	−2.96 (−2.45)	−0.47	2.91	179.0	120.4	−1.45	1.59	1.00
*m*CN	−3.40 (−3.04)	−0.91	2.89	178.8	122.2	−1.52	2.04	1.12
*m*F	−2.88 (−2.53)	−0.39	2.91	178.6	121.2	−1.44	1.56	0.99
*m*I	−2.91 (−2.53)	−0.42	2.91	179.4	120.6	−1.44	1.58	1.01
m$N(CH_3)_2$	−2.10 (−1.74)	+0.39	2.98	179.7	117.6	−1.28	0.76	0.75
mNH_2	−2.27 (−1.89)	+0.22	2.97	179.4	117.5	−1.31	0.90	0.80
m$NHCOCH_3$	−2.79 (−2.38)	−0.30	2.94	179.5	118.3	−1.38	1.34	0.91
mNO_2	−3.49 (−3.12)	−1.00	2.88	179.4	121.5	−1.54	2.09	1.16
mOCH_3	−2.41 (−2.05)	+0.08	2.96	178.0	117.8	−1.33	1.06	0.83
m$O(CH3)_2$	−2.27 (−1.89)	+0.22	2.94	178.5	121.4	−1.36	1.01	0.86
*m*OH	−2.46 (−2.09)	+0.03	2.94	179.2	119.6	−1.38	1.16	0.89
*o*Br	−2.64 (−2.08)	−0.15	2.88	178.3	128.2	−1.50	1.52	1.05
oCF_3	−2.95 (−2.36)	−0.46	2.87	178.1	125.1	−1.55	1.70	1.14
oCH_3	−2.40 (−1.87)	+0.09	2.95	179.4	119.3	−1.35	1.09	0.85
*o*Cl	−2.81 (−2.36)	−0.32	2.90	177.8	121.2	−1.48	1.53	1.05
*o*CN	−3.12 (−2.56)	−0.63	2.86	178.9	125.3	−1.58	1.87	1.20
*o*F	−2.83 (−2.30)	−0.34	2.88	179.2	122.8	−1.51	1.53	1.07
*o*I	−2.75 (−2.33)	−0.26	2.90	179.0	123.3	−1.48	1.49	1.05
o$N(CH_3)_2$	−2.28 (−1.77)	+0.21	2.96	177.5	117.7	−1.32	0.97	0.82
oNH_2	−2.71 (−2.21)	−0.22	2.96	179.1	117.7	−1.34	1.23	0.83
o$NHCOCH_3$	−3.54 (−2.99)	−1.05	2.93	178.9	118.3	−1.43	1.89	1.00
oNO_2	−3.18 (−2.72)	−0.69	2.84	177.5	127.1	−1.62	1.94	1.28

oOCH_3	−2.18 (−1.81)	+0.31	2.95	177.5	118.7	−1.35	0.93	0.84
o$O(CH3)_2$	−2.10 (−1.60)	+0.39	2.94	179.7	120.5	−1.37	0.90	0.86
*o*OH	−3.34 (−2.95)	−0.85	2.91	178.6	120.4	−1.46	1.81	1.00

[a] Interaction energies (E_{int}) and energy differences with respect to the unsubstituted complex (ΔE_{int}) are in kcal mol^{-1}. Interaction energies were also calculated at the M06-2X/aug-pVTZ-PP level of theory (in parenthesis). Geometries features are equilibrium distances (R_e, Å), and donor (O···I–C, α_{donor}) and acceptor (C–O···I, α_{acc}) angles. Molecular properties are the electron density at the Cl···O bond CP ($sign(\lambda_2) \cdot \rho$, a.u.), the most positive MEP value on the halogen atom ($V_{S,max}$, kcal mol^{-1}) and the charge transfer.

Table S4 Energetic values, geometric features and molecular properties of un- and substituted iodobenzene···NMA complexes[a]

R'	E_{int}	ΔE_{int}	R_e	α_{donor}	α_{acc}	$10^2 \times \rho$	$10^{-1} \times V_{S,max}$	$10^2 \times$ CT
H	−4.04 (−3.39)		3.00	178.4	120.8	−1.52	1.74	1.32
*p*Br	−4.63 (−4.06)	−0.59	2.98	178.9	121.8	−1.55	2.13	1.44
pCF_3	−4.97 (−3.97)	−0.93	2.96	177.9	121.5	−1.61	2.39	1.57
pCH_3	−3.89 (−3.42)	+0.15	3.01	178.3	120.5	−1.48	1.62	1.26
*p*Cl	−4.60 (−3.91)	−0.56	2.97	178.7	121.6	−1.59	2.12	1.47
*p*CN	−5.33 (−4.60)	−1.29	2.94	179.0	123.3	−1.68	2.65	1.67
*p*F	−4.44 (−3.70)	−0.40	2.98	178.7	121.5	−1.56	2.01	1.43
*p*I	−4.62 (−3.89)	−0.58	2.97	178.7	121.8	−1.59	2.15	1.48
p$N(CH_3)_2$	−3.33 (−2.89)	+0.71	3.03	178.8	120.6	−1.41	1.20	1.14
pNH_2	−3.48 (−2.92)	+0.56	3.02	178.5	120.3	−1.44	1.29	1.16
p$NHCOCH_3$	−4.12 (−3.45)	−0.08	3.00	178.0	120.6	−1.51	1.69	1.34
pNO_2	−5.52 (−4.89)	−1.48	2.93	178.9	123.1	−1.71	2.75	1.76
pOCH_3	−3.84 (−3.27)	+0.20	3.01	178.0	120.4	−1.49	1.59	1.24
p$O(CH3)_2$	−3.73 (−3.26)	+0.31	2.99	179.3	123.6	−1.51	1.55	1.33
*p*OH	−3.96 (−3.45)	+0.08	3.00	179.0	121.5	−1.50	1.68	1.29
*m*Br	−4.59 (−4.03)	−0.55	2.95	177.5	125.7	−1.63	2.13	1.54
mCF_3	−4.89 (−4.33)	−0.85	2.94	179.6	125.0	−1.66	2.34	1.60
mCH_3	−3.89 (−3.59)	+0.15	2.99	179.2	123.3	−1.52	1.62	1.30
*m*Cl	−4.59 (−3.97)	−0.55	2.94	178.8	126.4	−1.65	2.15	1.55
*m*CN	−5.22 (−4.36)	−1.18	2.92	178.9	126.9	−1.70	2.59	1.71
*m*F	−4.56 (−3.89)	−0.52	2.95	179.2	124.9	−1.63	2.12	1.52
*m*I	−4.58 (−4.03)	−0.54	2.95	179.2	125.6	−1.63	2.11	1.54
m$N(CH_3)_2$	−3.54 (−2.87)	+0.50	3.01	179.5	122.4	−1.46	1.33	1.26
mNH_2	−3.74 (−3.29)	+0.30	3.00	179.4	121.8	−1.49	1.46	1.25
m$NHCOCH_3$	−4.35 (−3.83)	−0.31	2.98	179.0	122.2	−1.57	1.91	1.40
mNO_2	−5.33 (−4.70)	−1.29	2.91	179.3	126.6	−1.73	2.65	1.74
mOCH_3	−3.96 (−3.59)	+0.08	3.00	178.6	121.1	−1.51	1.62	1.31
m$O(CH3)_2$	−3.85 (−3.24)	+0.19	2.98	179.0	124.8	−1.56	1.57	1.35
*m*OH	−4.01 (−3.48)	+0.03	2.97	179.0	125.9	−1.57	1.72	1.38
*o*Br	−4.56 (−4.07)	−0.52	2.92	179.8	127.2	−1.69	2.10	1.65
oCF_3	−4.82 (−4.28)	−0.78	2.91	178.0	125.2	−1.73	2.26	1.75
oCH_3	−3.89 (−3.39)	+0.15	2.99	178.3	122.0	−1.52	1.62	1.31
*o*Cl	−4.63 (−4.20)	−0.59	2.93	177.5	123.7	−1.67	2.10	1.61
*o*CN	−5.00 (−4.35)	−0.96	2.90	179.4	131.9	−1.76	2.44	1.76
*o*F	−4.66 (−3.96)	−0.62	2.92	178.8	125.3	−1.70	2.13	1.63
*o*I	−4.57 (−4.15)	−0.53	2.93	178.6	125.9	−1.69	2.08	1.64
o$N(CH_3)_2$	−3.74 (−3.22)	+0.30	2.98	177.9	123.0	−1.53	1.51	1.33
oNH_2	−4.10 (−3.68)	−0.06	2.99	178.9	122.8	−1.52	1.75	1.29
o$NHCOCH_3$	−5.02 (−4.29)	−0.98	2.96	178.8	122.9	−1.62	2.41	1.51
oNO_2	−5.25 (−4.65)	−1.21	2.86	178.2	136.0	−1.82	2.61	1.85

oOCH_3	−3.78 (−3.23)	+0.26	2.97	178.0	124.0	−1.55	1.53	1.34
o$O(CH3)_2$	−3.70 (−2.92)	+0.34	2.97	178.6	124.8	−1.56	1.51	1.34
*o*OH	−4.83 (−4.36)	−0.79	2.95	179.3	126.8	−1.65	2.32	1.51

[a] Interaction energies (E_{int}) and energy differences with respect to the unsubstituted complex (ΔE_{int}) are in kcal mol^{-1}. Interaction energies were also calculated at the M06-2X/aug-pVTZ-PP level of theory (in parenthesis). Geometries features are equilibrium distances (R_e, Å), and donor (O···I–C, α_{donor}) and acceptor (C–O···I, α_{acc}) angles. Molecular properties are the electron density at the Cl···O bond CP ($sign(\lambda_2) \cdot \rho$, a.u.), the most positive MEP value on the halogen atom ($V_{S,max}$, kcal mol^{-1}) and the charge transfer.

Table S5 NBO charges (q, e) of un- and substituted halobenzene···NMA complexes[a]

R	$10^1 \times q_X$			$10^1 \times q_O$			$10^1 \times q_R$		
	Cl	**Br**	**I**	**Cl**	**Br**	**I**	**Cl**	**Br**	**I**
H	0.258	0.968	1.992	−6.370	−6.421	−6.481			
*p*Br	0.355	1.083	2.122	−6.386	−6.437	−6.508	0.649	0.637	0.615
pCF_3	0.211	0.980	2.078	−6.401	−6.448	−6.521	0.011	0.004	−0.003
pCH_3	0.217	0.936	1.940	−6.364	−6.412	−6.485	0.363	0.323	0.317
*p*Cl	0.359	1.087	2.124	−6.397	−6.431	−6.510	0.031	0.021	−0.002
*p*CN	0.552	1.291	2.327	−6.415	−6.468	−6.543	−0.297	−0.303	−0.308
*p*F	0.319	1.038	2.074	−6.383	−6.433	−6.487	−3.385	−3.390	−3.397
*p*I	0.372	1.096	2.128	−6.388	−6.439	−6.510	1.559	1.545	1.523
p$N(CH_3)_2$	0.117	0.808	1.676	−6.341	−6.391	−6.463	−0.450	−0.724	−0.402
pNH_2	0.122	0.820	1.832	−6.350	−6.396	−6.462	−0.355	−0.357	−0.354
p$NHCOCH_3$	0.262	0.768	1.844	−6.380	−6.421	−6.485	−1.544	−1.522	−1.527
pNO_2	0.343	1.124	2.234	−6.423	−6.473	−6.546	−2.394	−2.402	−2.412
pOCH_3	0.212	0.922	1.932	−6.362	−6.409	−6.476	−2.035	−2.041	−2.045
p$O(CH3)_2$	−0.025	0.716	1.808	−6.357	−6.406	−6.478	−2.066	−2.070	−2.073
*p*OH	0.229	0.934	1.956	−6.361	−6.410	−6.480	−1.986	−1.989	−1.990
*m*Br	0.441	1.158	2.186	−6.395	−6.450	−6.518	0.692	0.674	0.640
mCF_3	0.504	1.218	2.243	−6.409	−6.461	−6.530	0.039	0.032	0.020
mCH_3	0.244	0.949	1.961	−6.373	−6.418	−6.489	0.398	0.390	0.347
*m*Cl	0.424	1.160	2.199	−6.390	−6.440	−6.525	0.079	0.047	0.022
*m*CN	0.525	1.277	2.323	−6.410	−6.466	−6.547	−0.226	−0.253	−0.269
*m*F	0.433	1.149	2.174	−6.390	−6.443	−6.519	−3.363	−3.373	−3.385
*m*I	0.424	1.146	2.188	−6.389	−6.441	−6.520	1.607	1.580	1.543
m$N(CH_3)_2$	0.201	0.876	1.737	−6.361	−6.404	−6.462	−0.496	−0.335	−0.345
mNH_2	0.206	0.913	1.928	−6.363	−6.409	−6.476	−0.250	−0.265	−0.305
m$NHCOCH_3$	0.289	1.009	2.030	−6.386	−6.426	−6.504	−1.480	−1.495	−1.511
mNO_2	0.580	1.122	2.375	−6.412	−6.463	−6.551	−2.320	−2.314	−2.334
mOCH_3	0.284	1.010	2.018	−6.366	−6.420	−6.492	−1.992	−2.017	−2.018

*m*O(CH3)$_2$	0.307	1.013	2.021	−6.365	−6.414	−6.489	−2.036	−2.046	−2.061
*m*OH	0.323	1.050	2.070	−6.371	−6.414	−6.496	−1.934	−1.955	−1.967
*o*Br	0.634	1.387	2.434	−6.386	−6.443	−6.520	0.950	0.900	0.808
*o*CF$_3$	0.712	1.446	2.475	−6.407	−6.445	−6.519	0.177	0.153	0.102
*o*CH$_3$	0.169	0.878	1.876	−6.374	−6.419	−6.487	0.548	0.533	0.467
*o*Cl	0.622	1.366	2.417	−6.379	−6.436	−6.508	0.311	0.265	0.185
*o*CN	0.816	1.575	2.654	−6.398	−6.455	−6.554	−0.134	−0.157	−0.208
*o*F	0.620	1.352	2.378	−6.378	−6.437	−6.517	−3.244	−3.280	−3.335
*o*I	0.572	1.333	2.398	−6.377	−6.438	−6.515	1.892	1.830	1.728
*o*N(CH$_3$)$_2$	0.295	1.017	2.047	−6.372	−6.412	−6.482	−0.867	−0.941	−1.049
*o*NH$_2$	0.053	0.775	1.785	−6.399	−6.435	−6.499	−0.041	−0.094	−0.150
*o*NHCOCH$_3$	−0.026	0.750	1.929	−6.435	−6.470	−6.541	−1.333	−1.386	−1.417
*o*NO$_2$	0.966	1.880	2.850	−6.410	−6.453	−6.575	−2.093	−2.271	−2.231
*o*OCH$_3$	0.448	1.168	2.178	−6.354	−6.410	−6.483	−1.844	−1.882	−1.941
*o*O(CH3)$_2$	0.252	1.155	2.158	−6.349	−6.399	−6.482	−1.906	−1.904	−1.964
*o*OH	0.164	0.892	1.926	−6.426	−6.463	−6.545	−1.766	−1.819	−1.892

[a] q_X, $q_{O,}$ and q_R are the NBO charges for the interacting halogen atom, oxygen atom, and the corresponding substituent, respectively.