A novel 8-hydroxyquinoline—pyazole based highly sensitive and selective Al(III) sensor in purely aqueous medium with intracellular application: experimental and computational studies†

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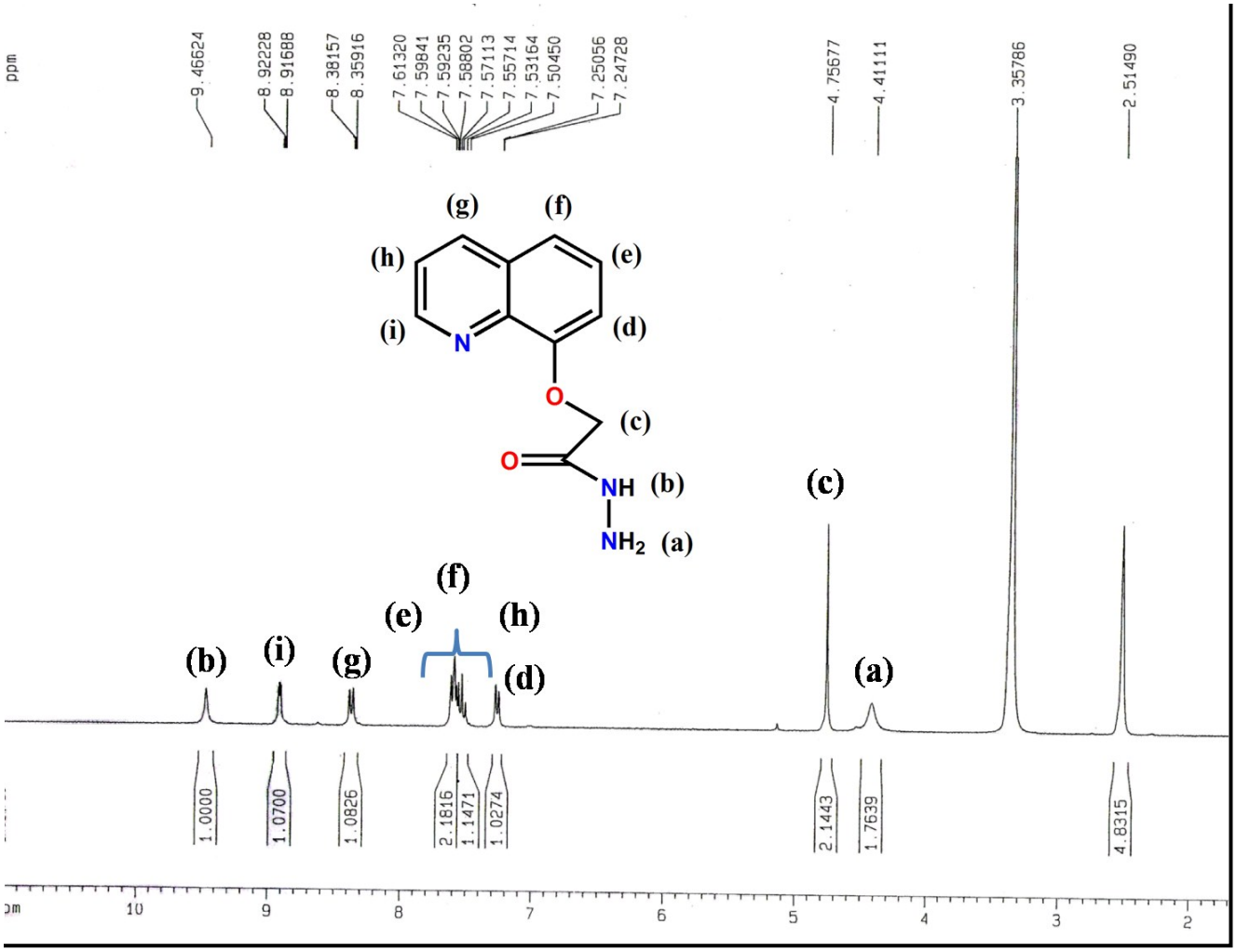


Fig. S1. ^{1}H-NMR spectrum of L^{1} in DMSO-d_6.

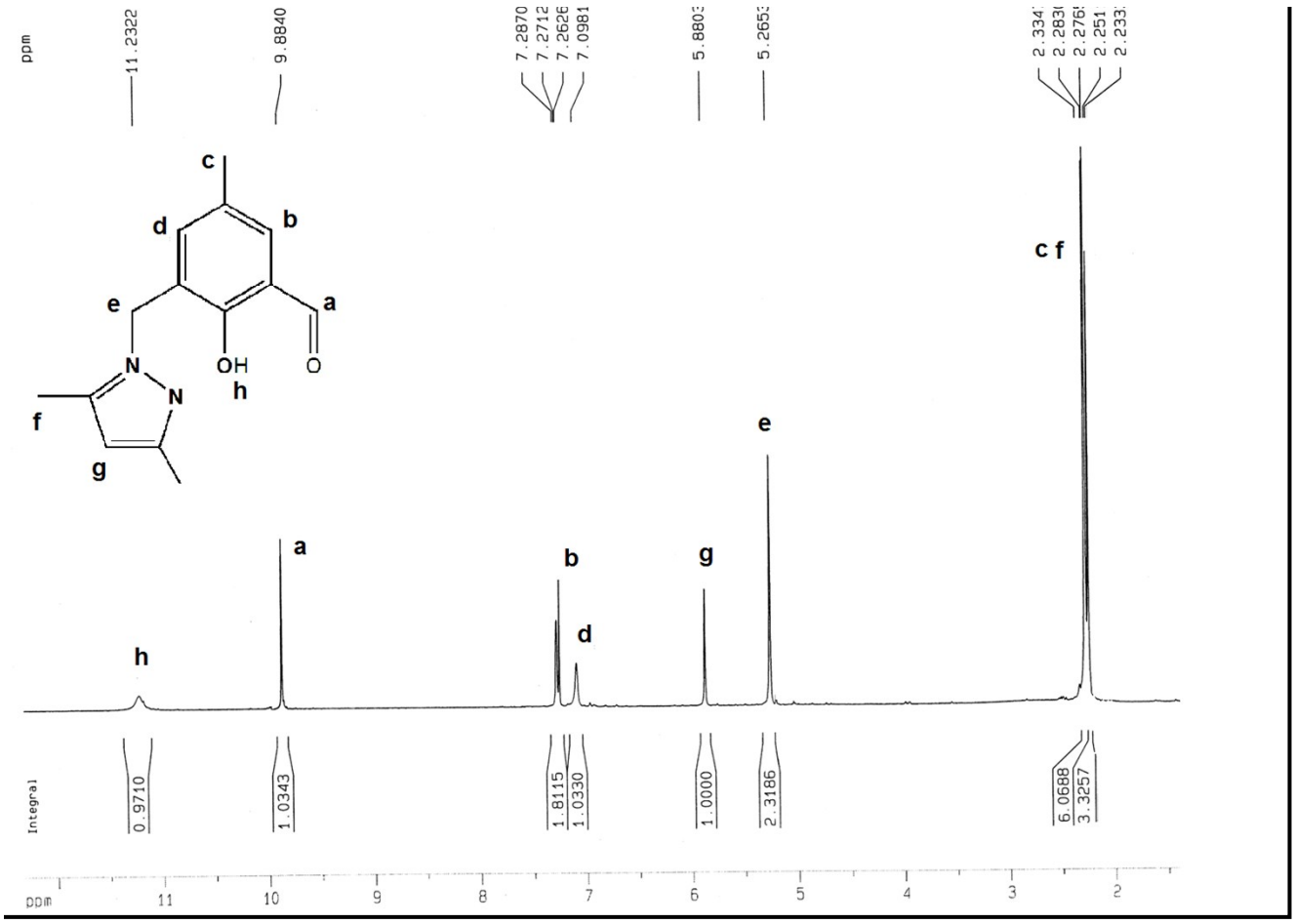


Fig.S2. ^{1}H-NMR spectrum of HL^{2} in $CDCl_3$.

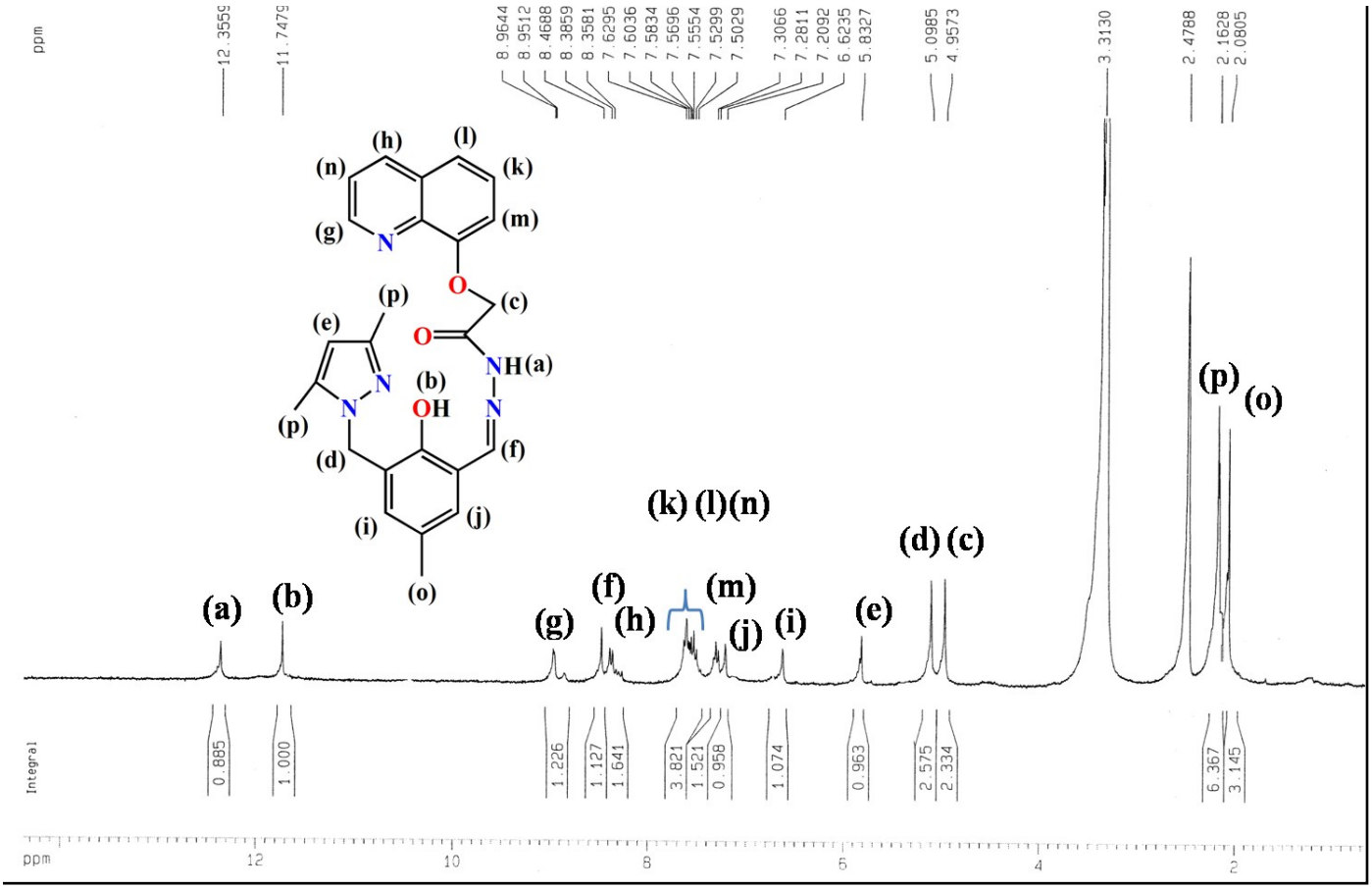


Fig.S3. ^{1}H-NMR spectrum of H_2L^3 in DMSO-d_6.

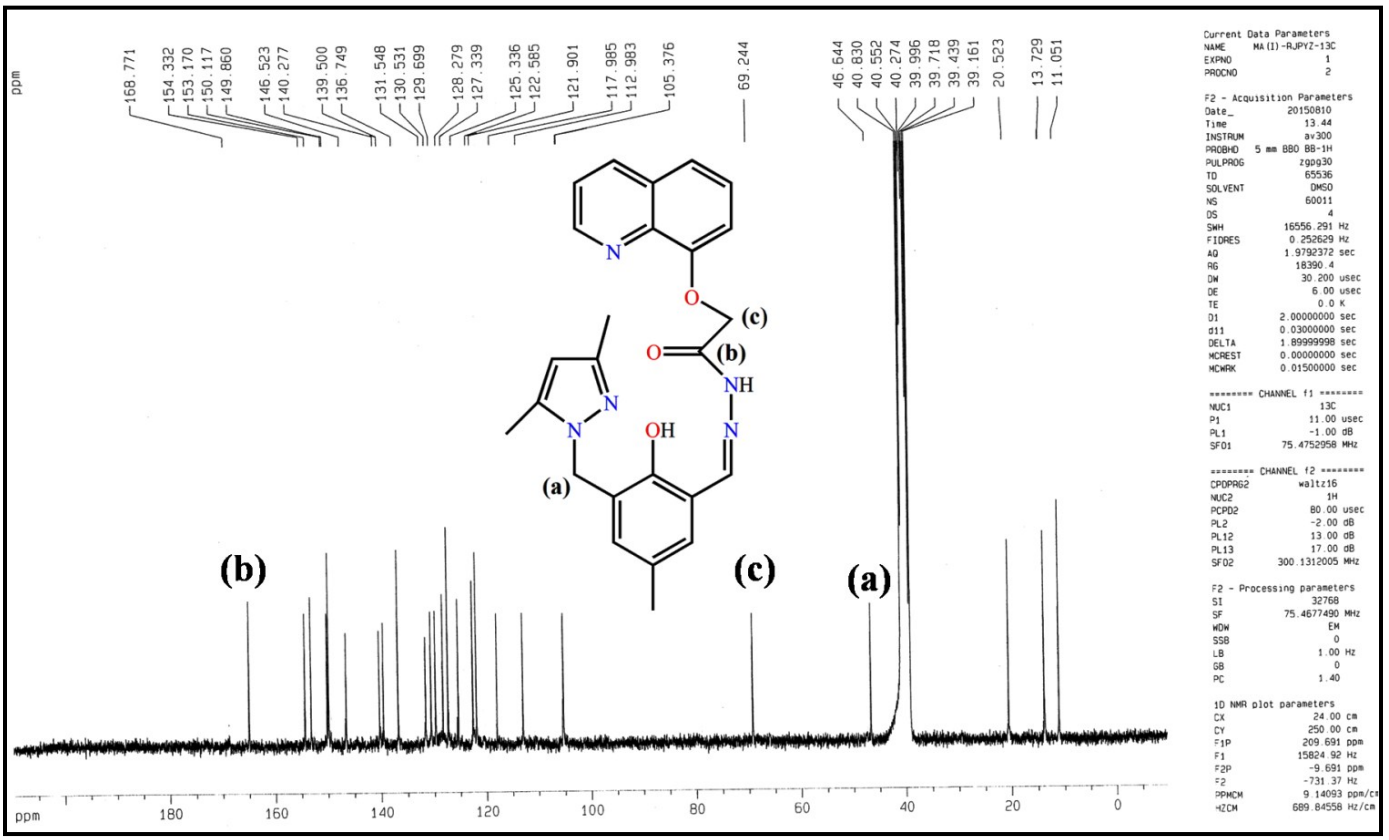


Fig. S4. ^{13}C-NMR spectrum of H_2L^3 in DMSO-d_6

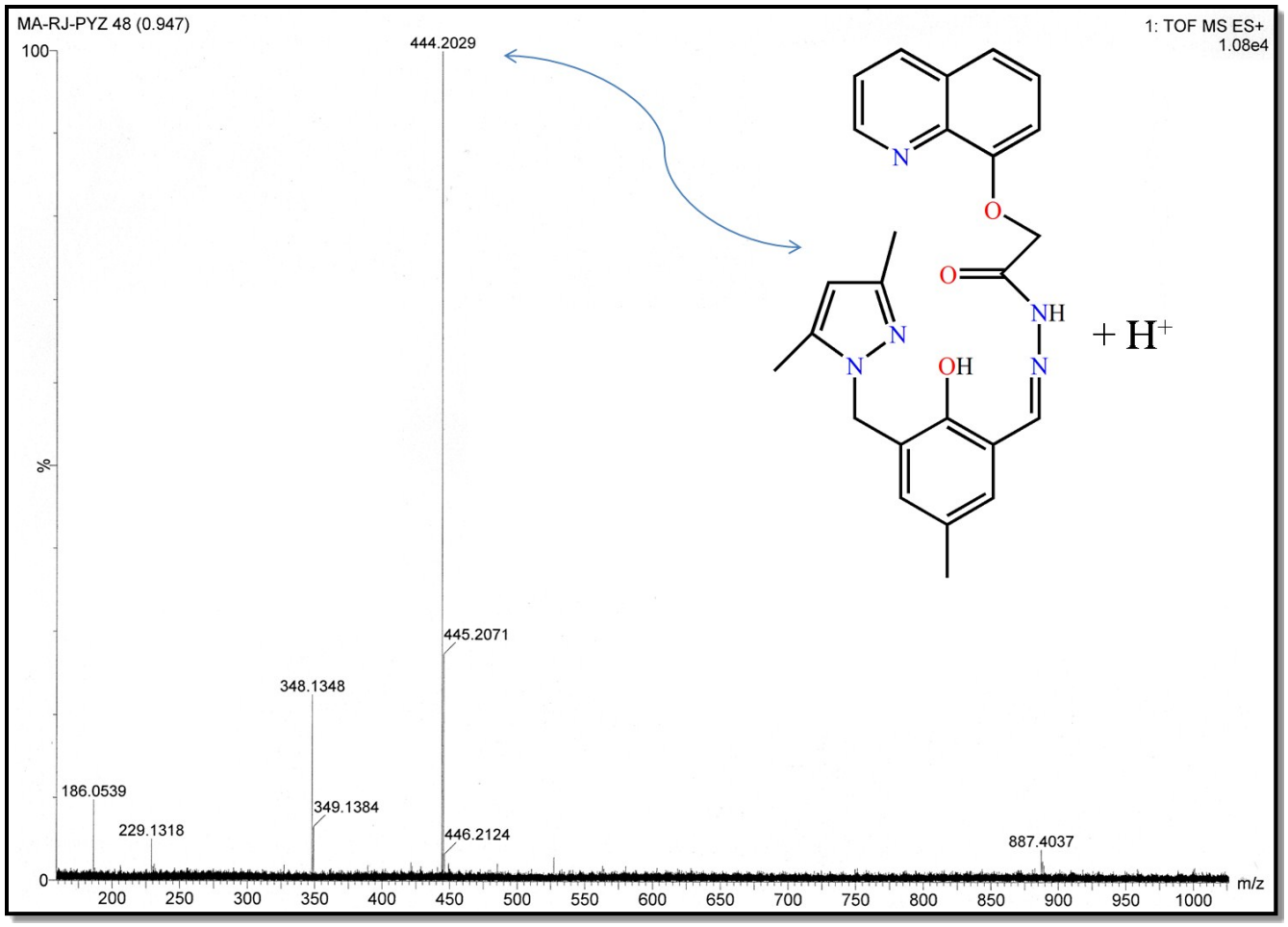


Fig. S5. Mass spectrum of 8Q-NH-Pyz in MeOH.

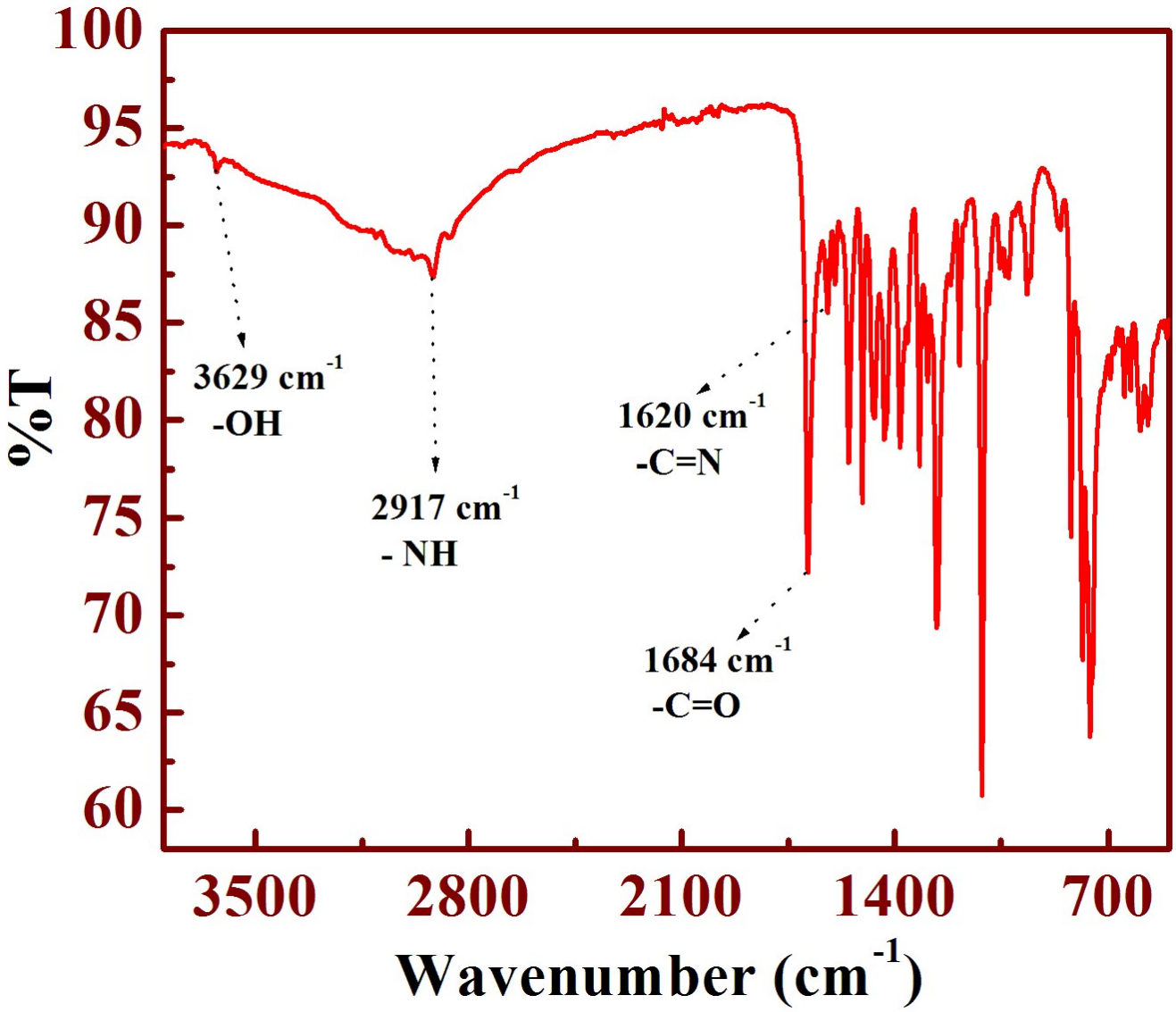


Fig. S6. IR spectrum of ligand 8Q-NH-Pyz.

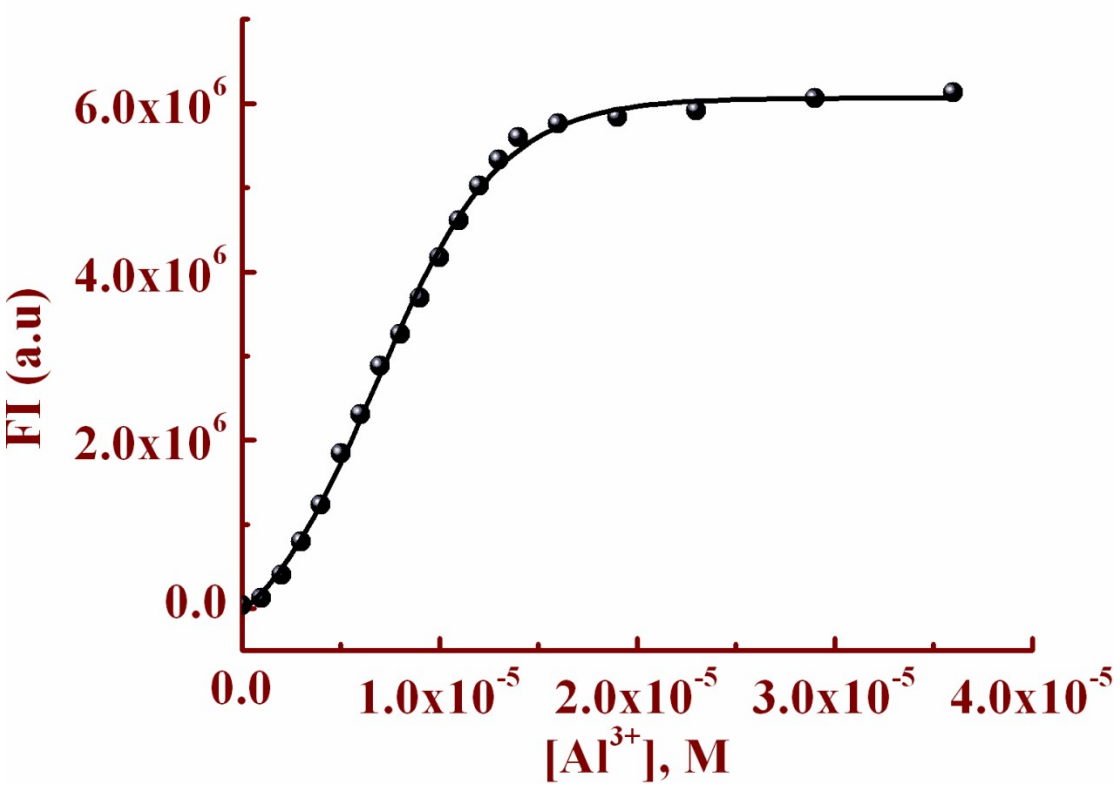


Fig.S7. Plot of F.I vs [Al^{3+}], M.

Calculation of LOD value

To determine the detection limit, fluorescence titration of **8Q-NH-Pyz**with $Al^{3+}$was carried out by adding aliquots of micromolar concentration of Al^{3+}.

However, the detection limit (LOD) of Al^{3+}have been calculated by 3σ method.

$$LOD = 3 \times S_d/S$$

where S_d is the standard deviation of the intercept of the blank (**8Q-NH-Pyz**) obtained from a plot of FI vs. [**8Q-NH-Pyz**], and S is the slope obtained from linear part of the plot of FI vs. [Al^{3+}].

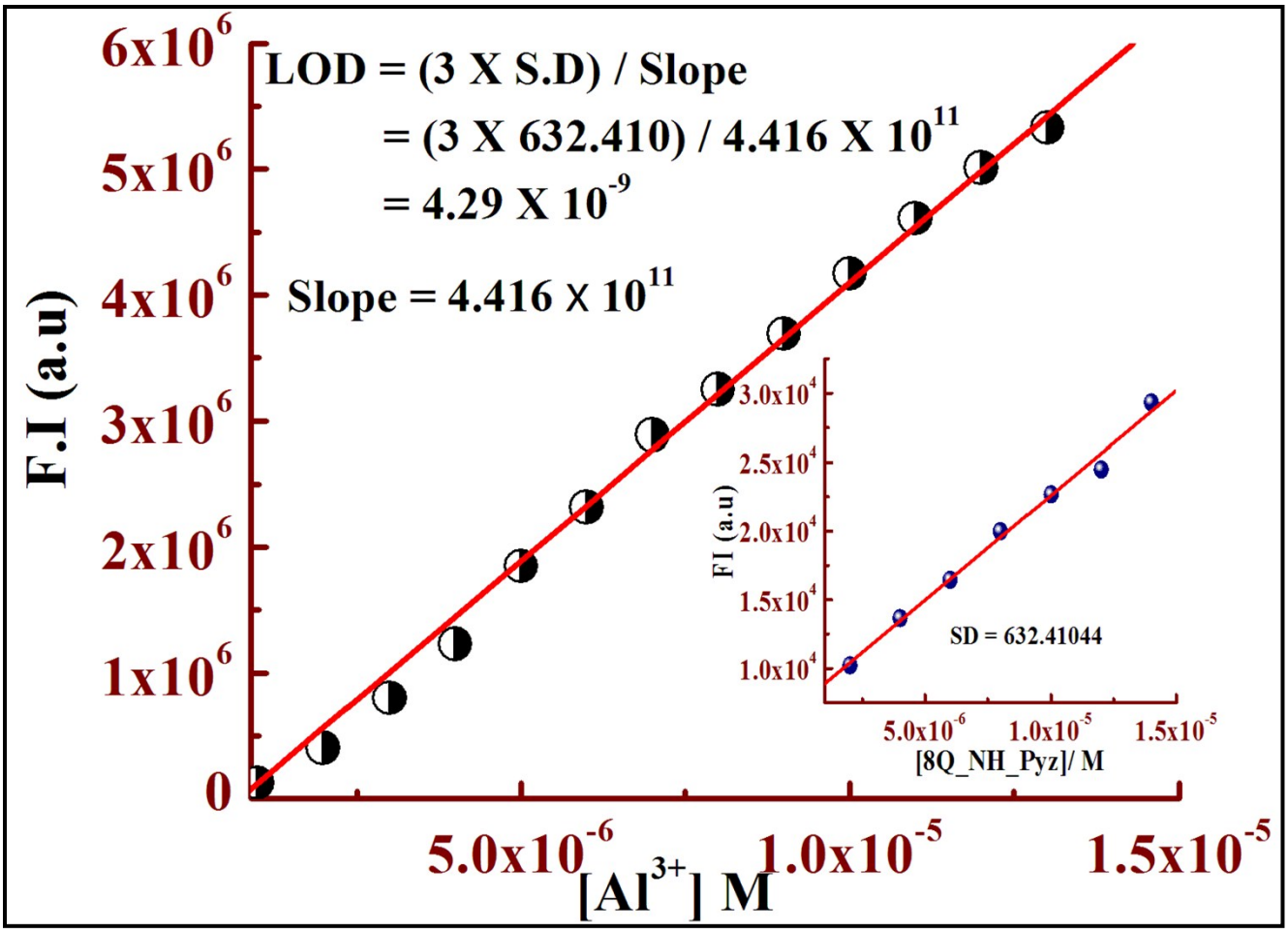


Fig.S8 LOD determination of Al^{3+}

JOB's Plot

This method is based on the measurementof a series of solutions in which molar concentrations of two reactants varybut their sum remains constant. The fluorescence intensity of each solution was measuredat a suitable wavelength and plotted against the mole fraction of one reactant. Amaximum in fluorescence intensity appeared at themole ratio corresponding to the combiningratio of the reactants.The composition of the complex was determined by JOB's method and found to be (1:1) with respect to ligand for Al^{3+}.

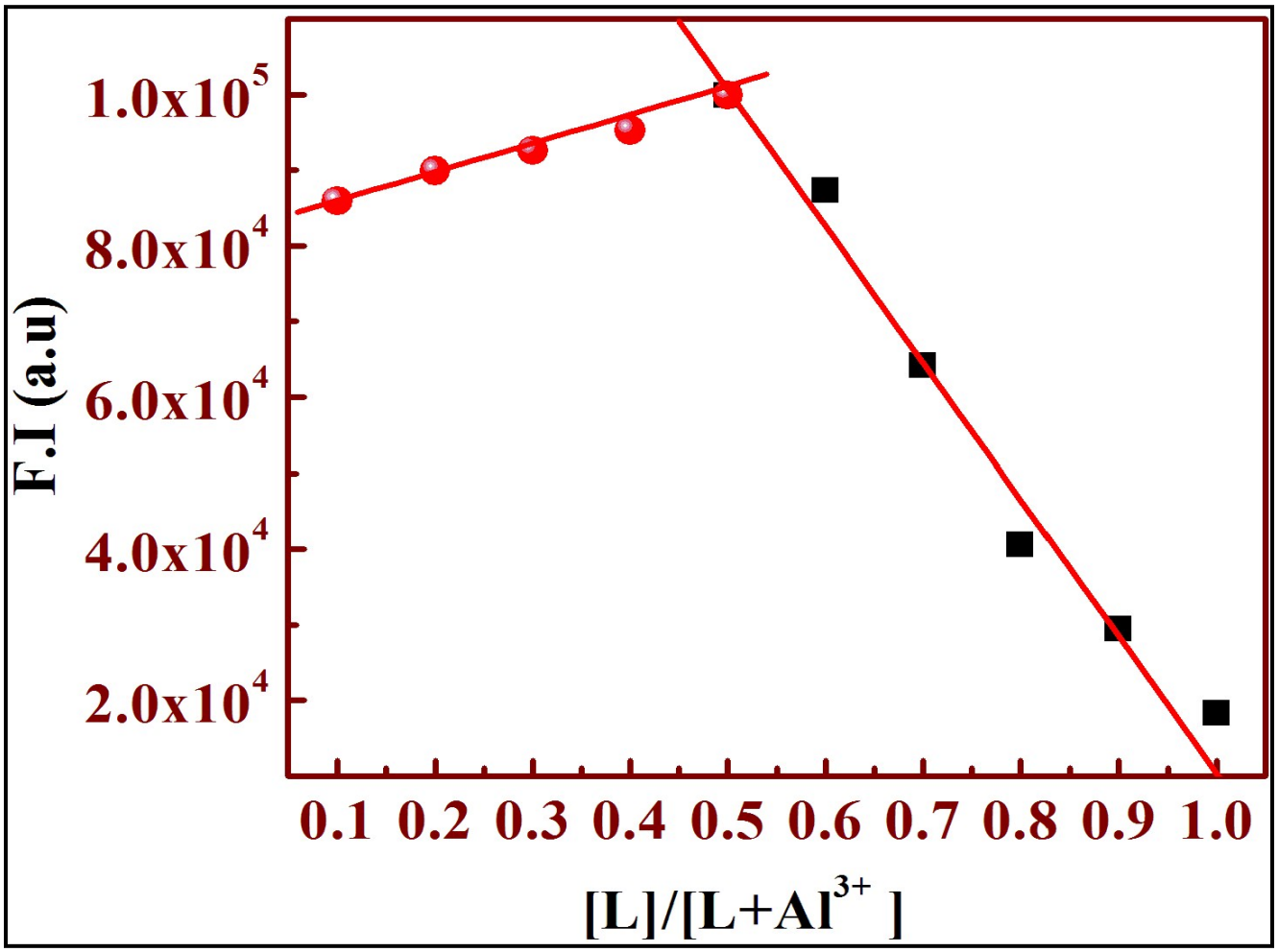


Fig.S9. JOB's plot for Al^{3+}.

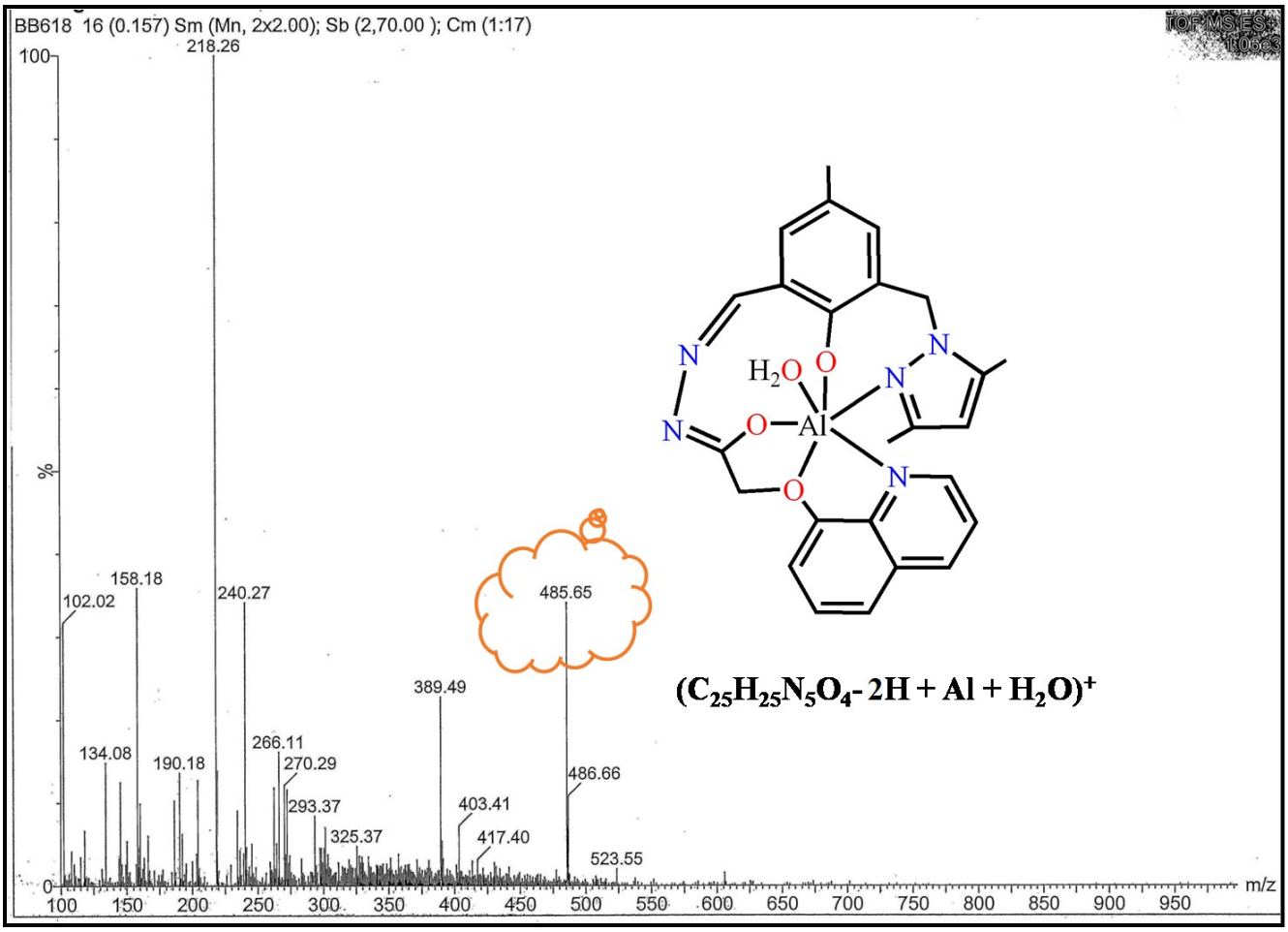


Fig.S10. Mass spectra of [(8Q-NH-Pyz) - 2H + Al + H_2O]$^+$.

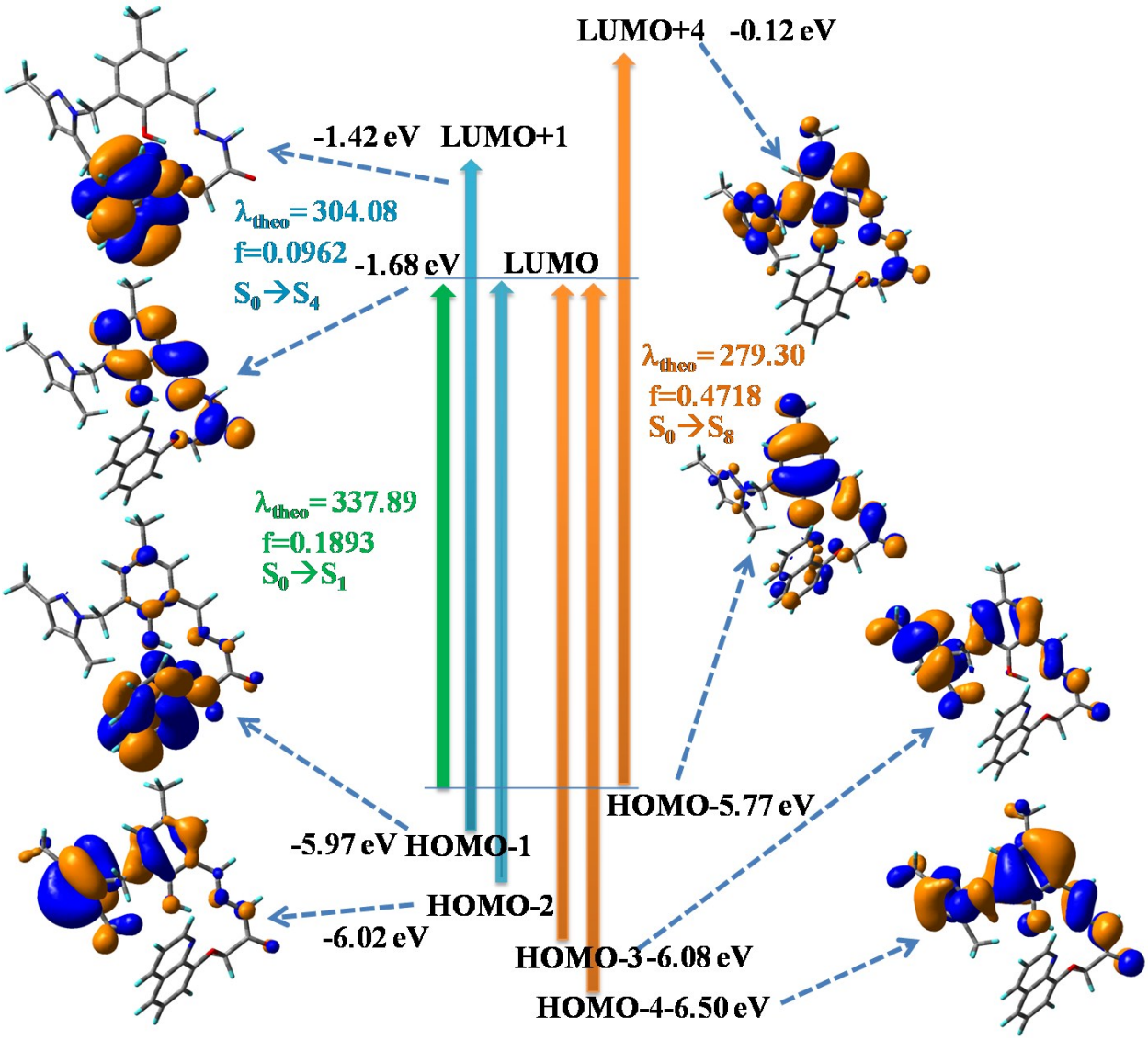


Fig. S11. Frontier molecular orbitals involved in the UV-Vis absorption of ligand 8Q-NH-Pyz (H_2L^3).

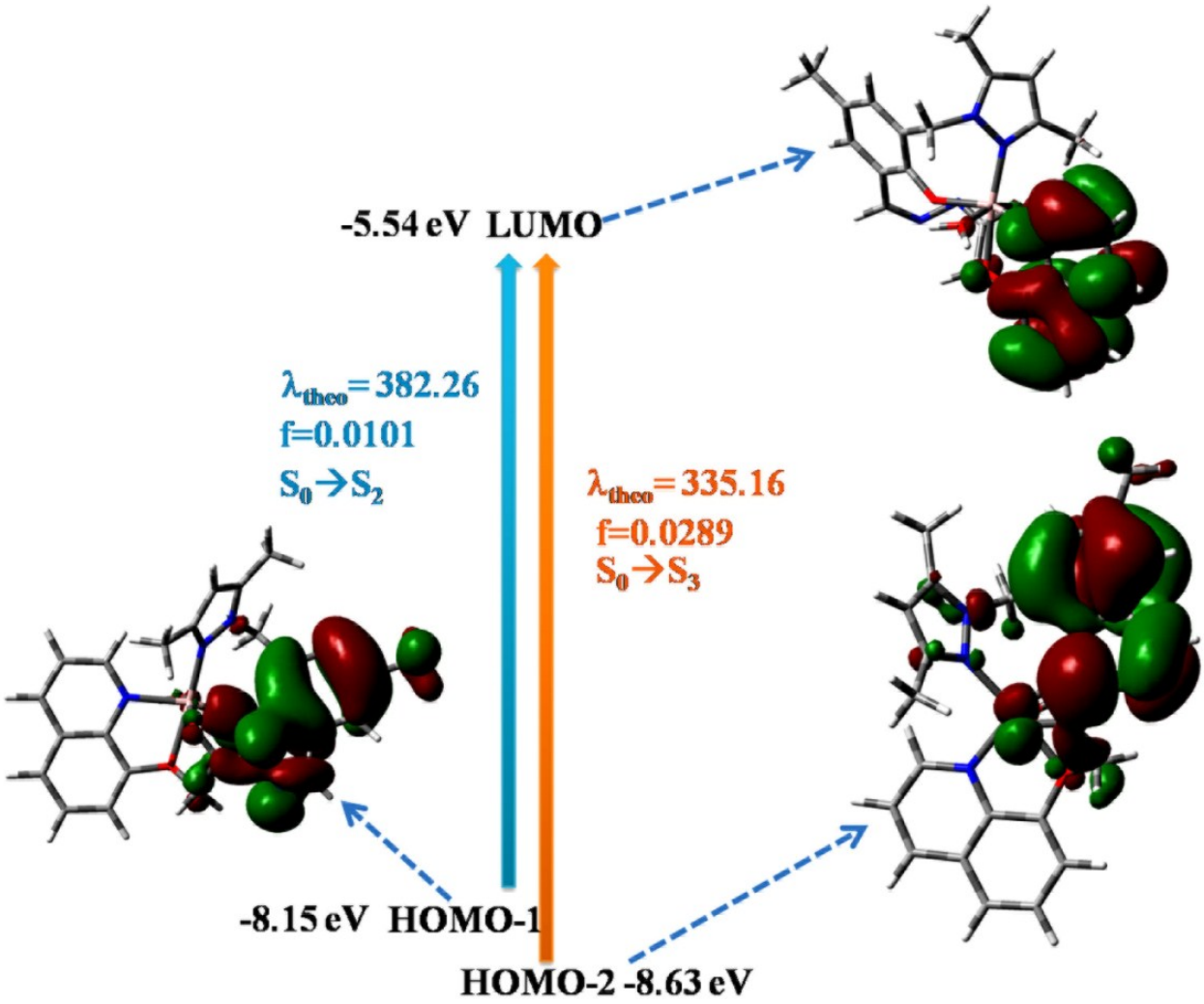


Fig. S12. Frontier molecular orbitals involved in the UV-Vis absorption of complex $[Al(L^3)(H_2O]^+$.

Calculation of Quantum Yield:

Fluorescence quantum yields (Φ) were estimated by integrating the area under the fluorescence curves using the equation,

$$\Phi_{sample} = (OD_{std} \times A_{sample})/(OD_{sample} \times A_{std}) \times \Phi_{std}$$

where A_{sample} and A_{std} are the area under the fluorescence spectral curves and OD_{sample} and OD_{std} are the optical densities of the sample and standard, respectively at the excitation wavelength. Quninesulphate has been used as the standard with Φ_{std} = 0.54 in water formeasuring the quantum yields of **8Q-NH-Pyz** and of **8Q-NH-Pyz–Al^{3+}**systems.

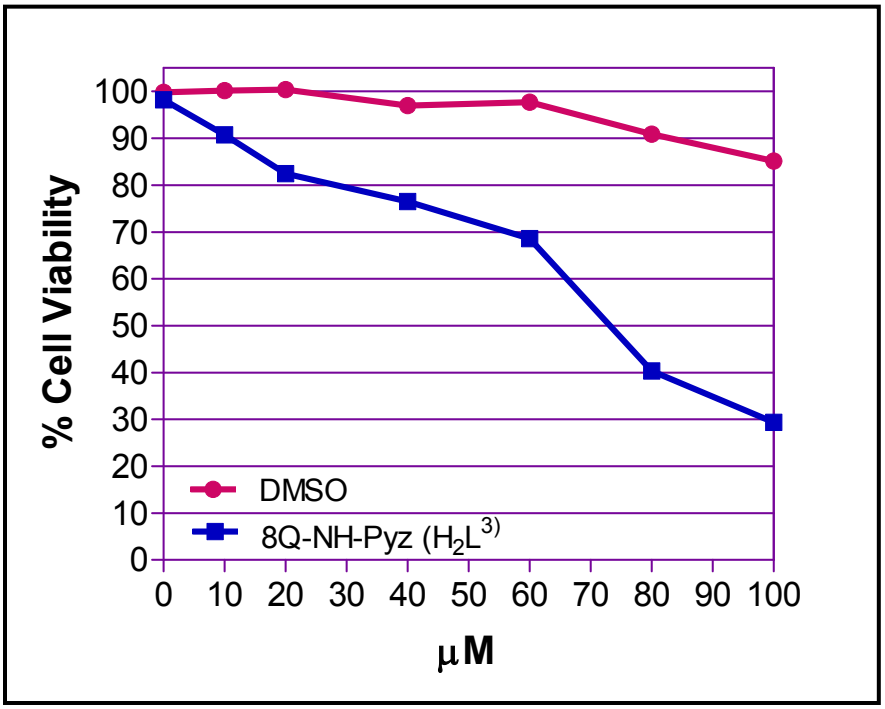
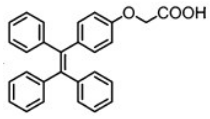
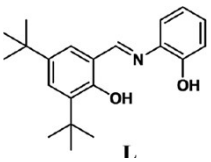
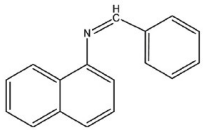
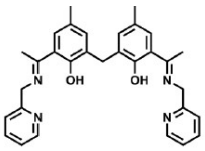
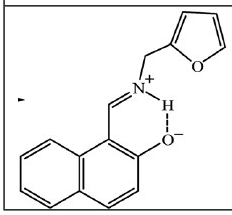
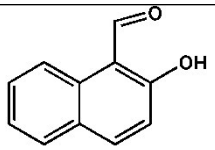
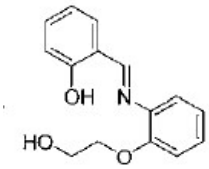
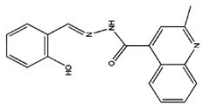
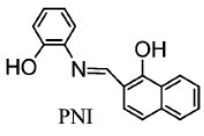
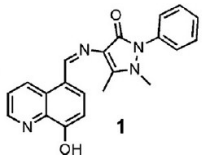
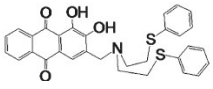
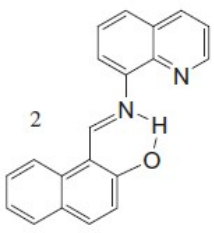
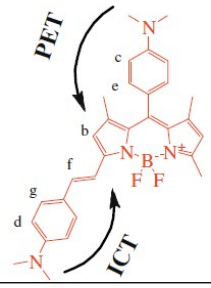
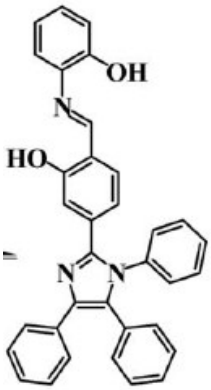
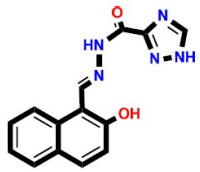
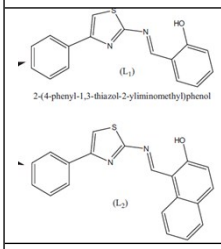
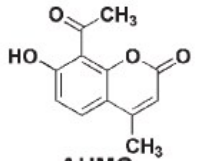
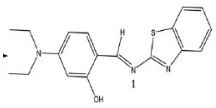


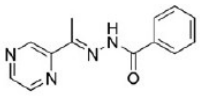
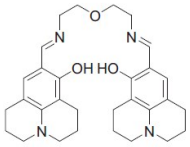
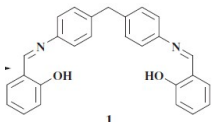
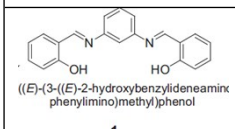
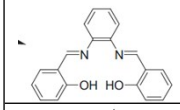
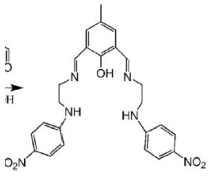
Fig.S13. MTT assay of ligand 8Q-NH-Pyz.

Table S1. List of some non-dye-based Al^{3+} sensors

Ligand	K_d/K_f	Solvent	LOD	Quantum Yield	Biological study	Fold	Ref
	-	DMSO/H_2O = 2:98	21.6 nM	-	Done	-	1
	5.96×10^3 M^{-1}	20 mM HEPES, 1% EtOH	29.4 nM	0.59	Done	337	2
	0.4×10^6 M^{-1}	1 : 1 (v/v) CH_3CN–H_2O	50 µM	-	Done	42	3
	3.61×10^9 M^{-1}	MeOH : H_2O (99 : 1, v/v)	0.7 mM	0.106	-	153	4
	0.35 $\times 10^5$ M^{-1}	DMSO/water: 1/100	60µM	0.29	Done	11	5

	8.32×10^{6} M^{-1}	EtOH/H_2O (95 : 5, v/v)	3.28 µM	-	-	12	6
	5.23×10^{5} M^{-1}	EtOH–H_2O (95 : 5 v/v)	0.89 µM	0.11	-	250	7
	5.6×10^{4} M^{-1}	Ethanol	0.72 µM	-	-	220	8
	2.5×10^{3} M^{-1}	50 mM Bis–Tris buffer	-	-	Done	100	9
	log β) is deduced to be 8.012	10% (v/v) methanol aqueous medium (acetate buffer, pH 4.5)	below 10^{-7} M	-	-	30	10
	8.84×10^{3} M^{-1}	H_2O/EtOH (1:1, v/v).	0.50 µM	-	-	110	11
	log Ka) determined to be 9.2	DMF	least down to 1 µM	-	-	-	12

	1.6×10^{-3}	6% HEPES in acetonitrile, v/v	80 µM	-	Done	-	13
	8.46×10^{5} M^{-1}	(50% H_2O/THF v/v	22 nM	0.07	Done	6	14
	1.26×10^{3} M^{-1}	MeCN–H_2O (v/v,1/1)	9.82 µM	-	-	230	15
	-	Methanol	1.0 µM and 0.75 µM	-	-	50	16
	-	MeOH–H_2O (95 : 5, v/v).	-	0.0154	-	17	17
	7.0×10^{3} M^{-1}	CH_3CN–H_2O (50 : 50, v/v)	0.42 µM	-	Done	-	18

	1.24×10^7 M^{-1}	EtOH	0.1 μM	-	-	800	19
	5.02×10^4 M^{-1}	MeCN–H_2O (9 : 1, v/v)	6.03 μM	-	-	154	20
	5.1×10^3 M^{-1}	DMF–H_2O HEPES buffer (7 : 3, v/v)	5 μM	-	-	10	21
	9.91×10^3 M^{-1}	THF–H_2O HEPES buffer (7 : 1, v/v)	3 μM	-	-	-	22
 ((*E*)-(3-((*E*)-2-hydroxybenzylideneamino phenylimino)methyl)phenol 1 	1.41×10^4 and 1.59×10^4 M^{-1}	MeOH	47.9 nM and 82.8 nM	-	-	-	23
	5.29×10^4 M^{-1}	MeOH–H_2O (8 : 2, v/v	7.55 mM	0.011	Done	-	24

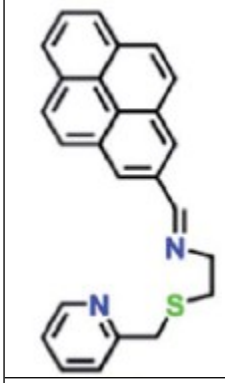
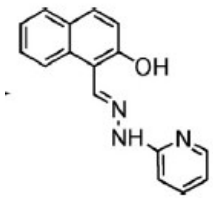
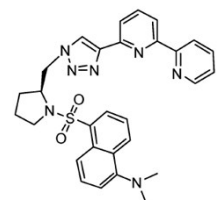
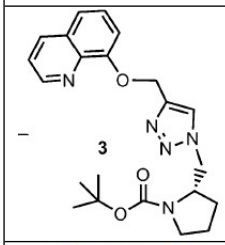
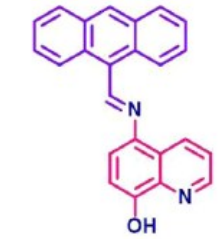
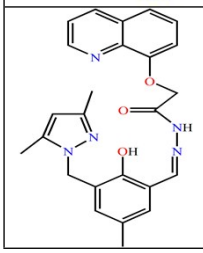
	2.55×10^{-4}M	MeOH–H_2O (9 : 1, v/v	15 nM	-	Done	7.4	25
	$4.87\times10^{4}M^{-1}$.	EtOH/H_2O (1:9, v/v, pH 5.3)	36.6 nM.	0.45	Done	-	26
	(log K_a) 3.94	in CH_3CN	-	-	-	-	27
	log Ka 13.04	1% CH_3CN Water	at least down to 10 μM	-	-	-	28
	$2.10\times10^{2}M^{-1}$	ACN:H_2O (1:9)	1.08×10^{-6} M		Done	-	29
	K_d= 1.76×10^{-5} M	In 10mM HEPES buffer	4.29 nM	0.28	Done	157	This Work

Table S2. List of some selected bond lengths of 8Q-NH-Pyz in the ground state calculated at B3LYP Levels.

Bond Lengths (Å)			
Al42-N37	1.994	Al42-O34	1.850
Al42-N16	2.050	Al42-O23	1.879
Al42-O17	2.184	Al-O57w	2.030
Bond Angles (°)			
O57-Al42-O23	159.74	O34-Al42-O17	87.22
N37-Al42-017	171.66	O17-Al42-N16	78.30
O57-AL42-N37	103.26	N16-Al42-N37	98.57
O17-Al42-O23	75.92	O34-Al42-N37	98.36
O57-Al42-O17	84.11		

Table S3. Some selected geometrical parameters for $[Al(L^3)(H_2O)]^+$ (1)complex in the ground state calculated at B3LYP Levels.

Al42-N37	1.994	Al42-O34	1.850
Al42-N16	2.050	Al42-O23	1.879
Al42-O17	2.184	Al-O57w	2.030
Bond Angles (°)			
O57-Al42-O23	159.74	O34-Al42-O17	87.22
N37-Al42-017	171.66	O17-Al42-N16	78.30
O57-AL42-N37	103.26	N16-Al42-N37	98.57
O17-Al42-O23	75.92	O34-Al42-N37	98.36
O57-Al42-O17	84.11		

Table S4. Vertical excitation energies and oscillator strengths (f_{cal}) of some low-lying excited singlet states obtained from TDDFT// B3LYP/6-31+G calculations of 8Q-NH-Pyz**.**

Electronic transition	Composition	Excitation energy	Oscillator strength($\boldsymbol{f_{cal}}$)	CI	λ_{exp} (nm)
$S_0 \rightarrow S_1$	HOMO→ LUMO	3.6694 eV(338 nm)	0.1893	0.67888	336
$S_0 \rightarrow S_4$	HOMO–1→ LUMO+1	4.0773 eV (304 nm)	0.0962	0.68059	300
	HOMO–2→ LUMO			0.11597	
$S_0 \rightarrow S_8$	HOMO→ LUMO + 4	4.4392 eV(279nm)	0.4718	0.10251	288
	HOMO–3→ LUMO			0.17038	
	HOMO–4→ LUMO			0.63802	

Table S5. Vertical excitation energies and oscillator strengths (f_{cal}) of some low-lying excited singlets obtained from TDDFT// B3LYP/6-31+G calculations of 8Q-NH-Pyz-Al^{3+} complex (1).

Electronic transition	Composition	Excitation energy	Oscillator strength (*f*)	CI	λ_{exp} (nm)
$\mathbf{S_0 \rightarrow S_2}$	HOMO – 1 → LUMO	3.24 eV (382.26 nm)	0.0101	0.70274	380
$\mathbf{S_0 \rightarrow S_3}$	HOMO – 2 → LUMO	3 .6992 eV(335.16 nm)	0.0289	0.68281	337

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