Supporting Information

Novel heterobimetallic Ir(III)-Re(I) complexes: design, synthesis and antitumor mechanism investigation

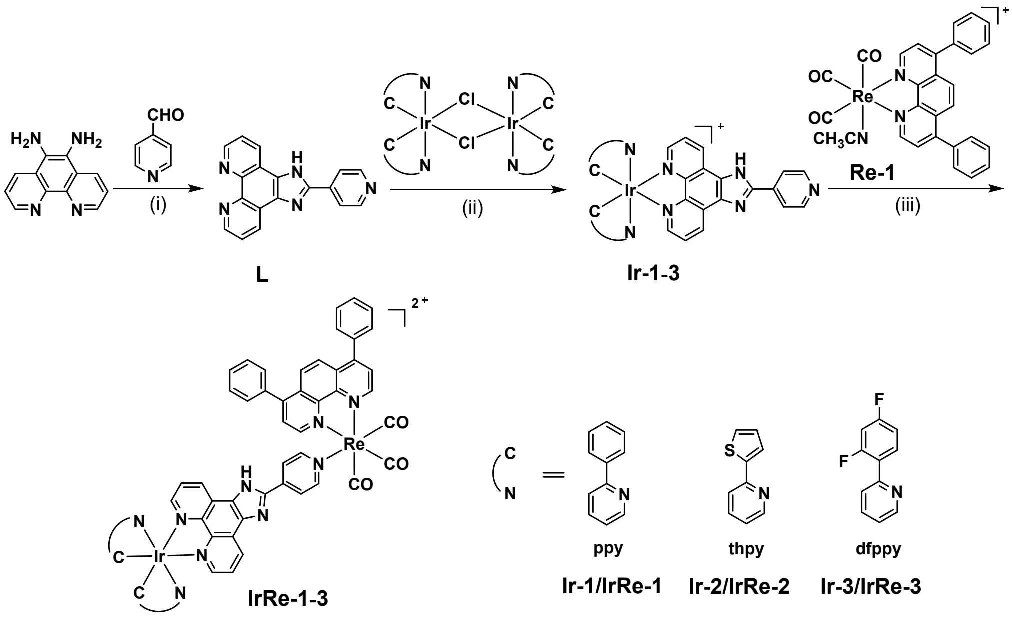
Jun-Jian Lu,[a] Xiu-Rong Ma,[a] Kai Xie,[a] Pei-Xin Yang,[a] Rong-Tao Li*[a] and Rui-Rong Ye*[a]

[a] *Faculty of Life Science and Technology, Kunming University of Science and Technology, Kunming 650500, P. R. China*

*Corresponding author.

E-mail addresses: rongtaolikm@163.com (R.-T. Li), yerr@mail2.sysu.edu.cn (R.-R. Ye).

Scheme S1 Synthetic routes of **IrRe-1–3**.



Condition: (i) CH_3CH_2OH, reflux, 24 h;
(ii) MeOH/CH_2Cl_2, N_2, 55 ^oC, 5 h;
(iii) acetone, N_2, 24 h.

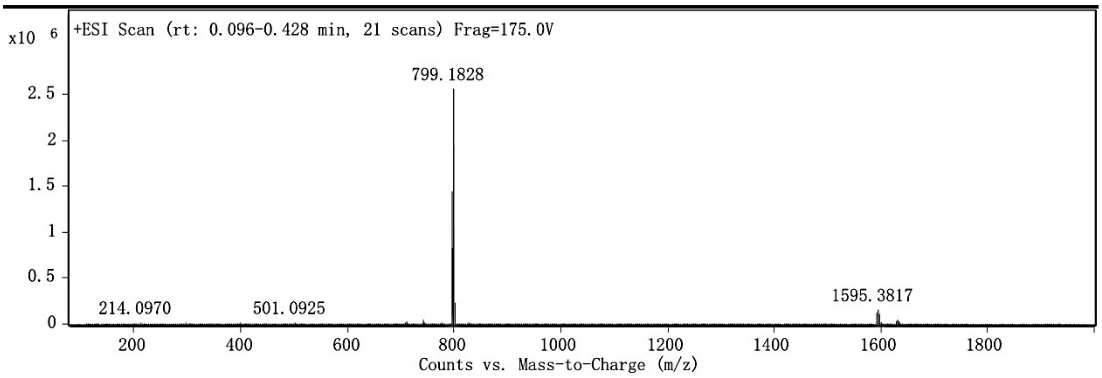


Fig. S1 ESI-MS characterization of **Ir-1**, 799.1828 $[M-PF_6]^+$.

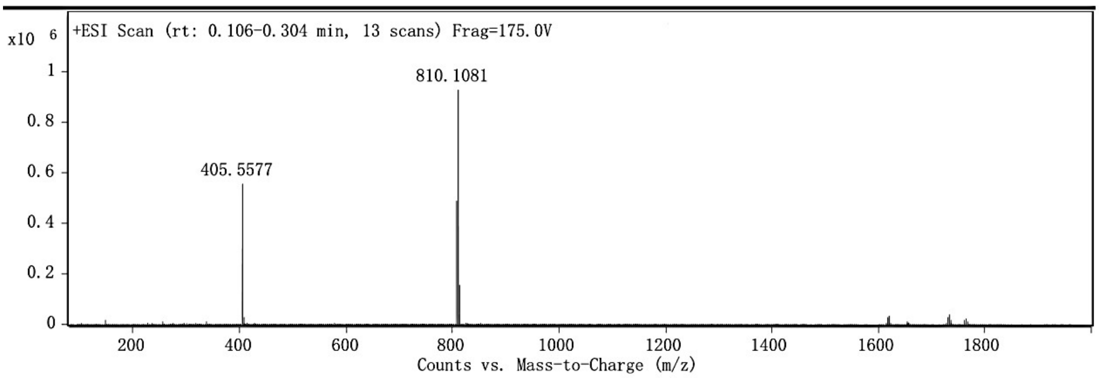


Fig. S2 ESI-MS characterization of **Ir-2**, 405.5577 $[M-PF_6+H]^{2+}$, 810.1081 $[M-PF_6]^+$.

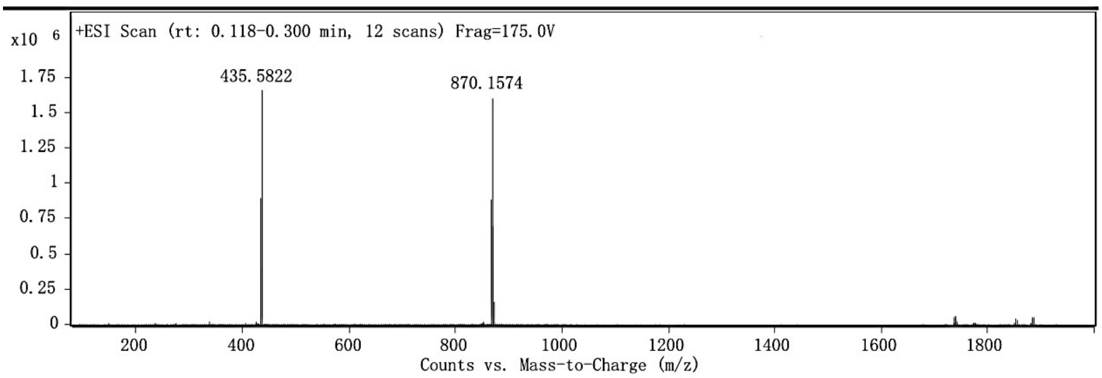


Fig. S3 ESI-MS characterization of **Ir-3**, 435.5822 $[M-PF_6+H]^{2+}$, 870.1574 $[M-PF_6]^+$.

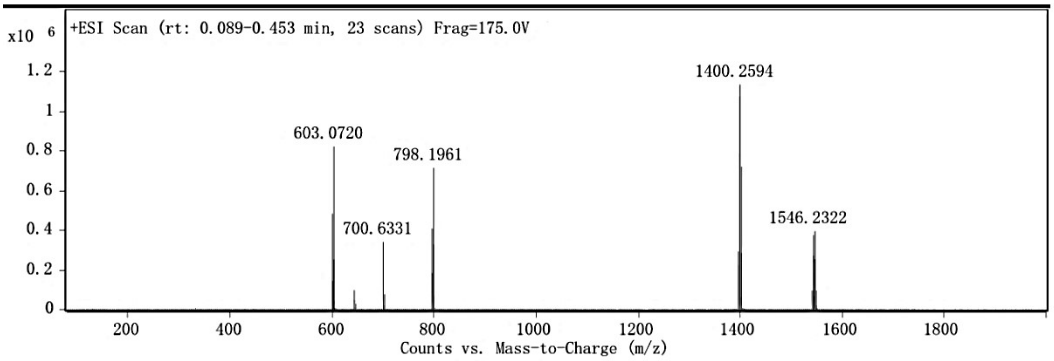


Fig. S4 ESI-MS characterization of **IrRe-1**, 603.0720 [M-**L**-Ir(ppy)$_2$-2PF$_6$]$^+$, 700.6331 [M-2PF$_6$]$^{2+}$, 798.1961 [M-Re(DIP)(CO)$_3$-2PF$_6$]$^+$, 1400.2591 [M-2PF$_6$-H]$^+$, 1546.2322 [M-PF$_6$]$^+$.

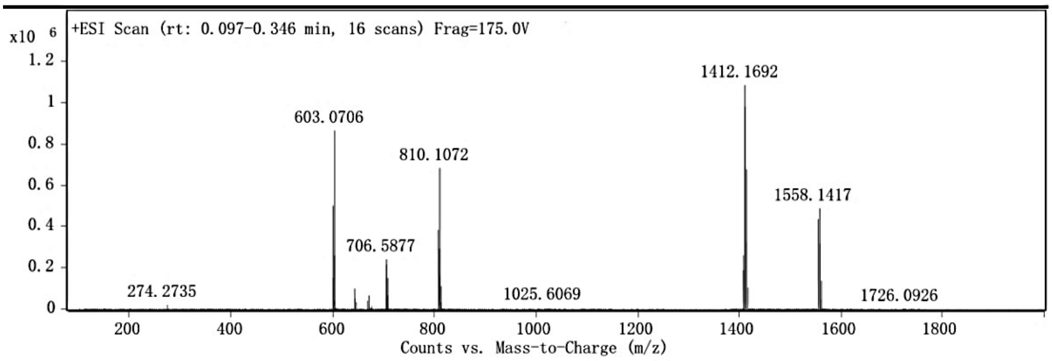


Fig. S5 ESI-MS characterization of **IrRe-2**, 603.0706 [M-**L**-Ir(thpy)$_2$-2PF$_6$]$^+$, 706.5877 [M-2PF$_6$]$^{2+}$, 810.1072 [M-Re(DIP)(CO)$_3$-2PF$_6$]$^+$, 1412.1692 [M-2PF$_6$-H]$^+$, 1558.1417 [M-PF$_6$]$^+$.

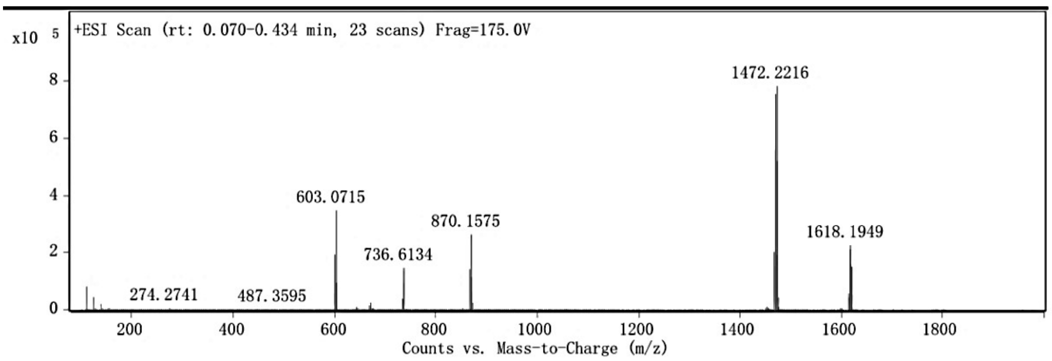


Fig. S6 ESI-MS characterization of **IrRe-3**, 603.0715 [M-**L**-Ir(dfppy)$_2$-2PF$_6$]$^+$, 736.6134 [M-2PF$_6$]$^{2+}$, 870.1575 [M-Re(DIP)(CO)$_3$-2PF$_6$]$^+$, 1472.2216 [M-2PF$_6$-H]$^+$, 1618.1949 [M-PF$_6$]$^+$.

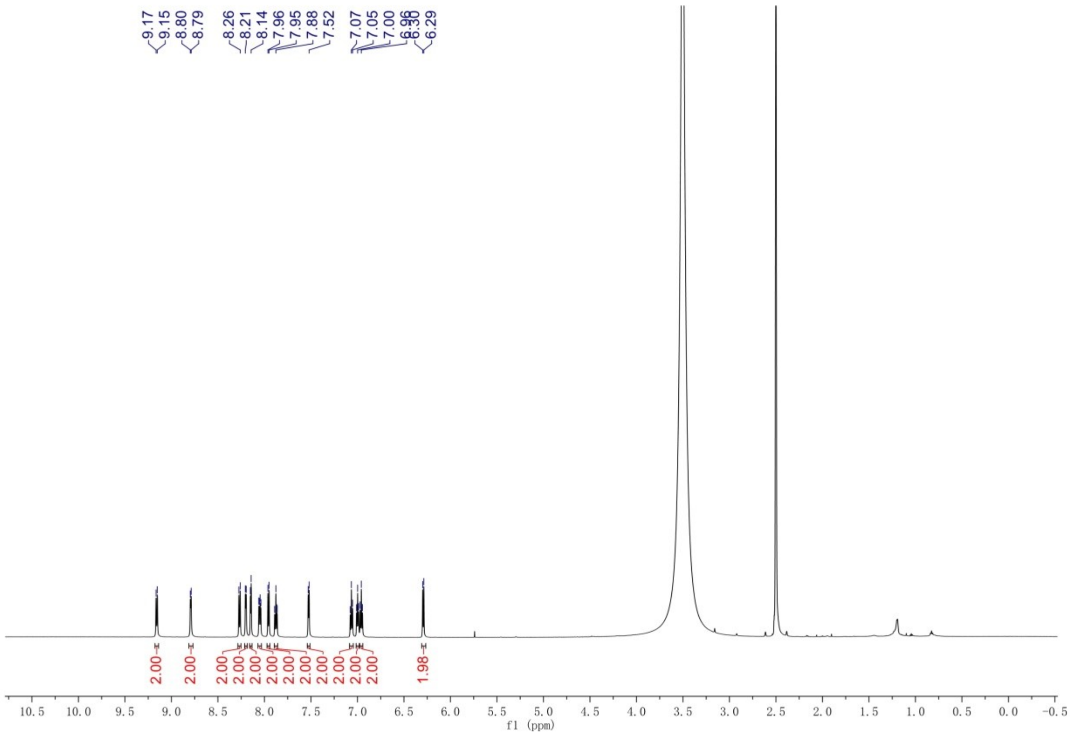


Fig. S7 ^{1}H NMR spectrum of **Ir-1**.

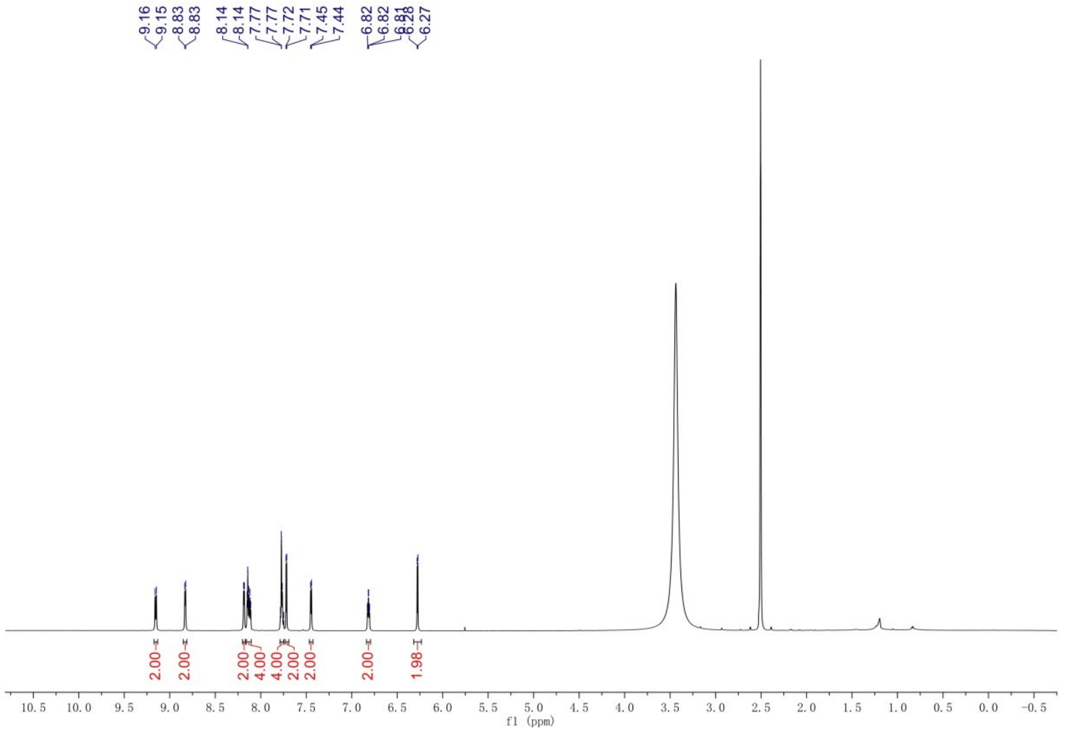


Fig. S8 ^{1}H NMR spectrum of **Ir-2**.

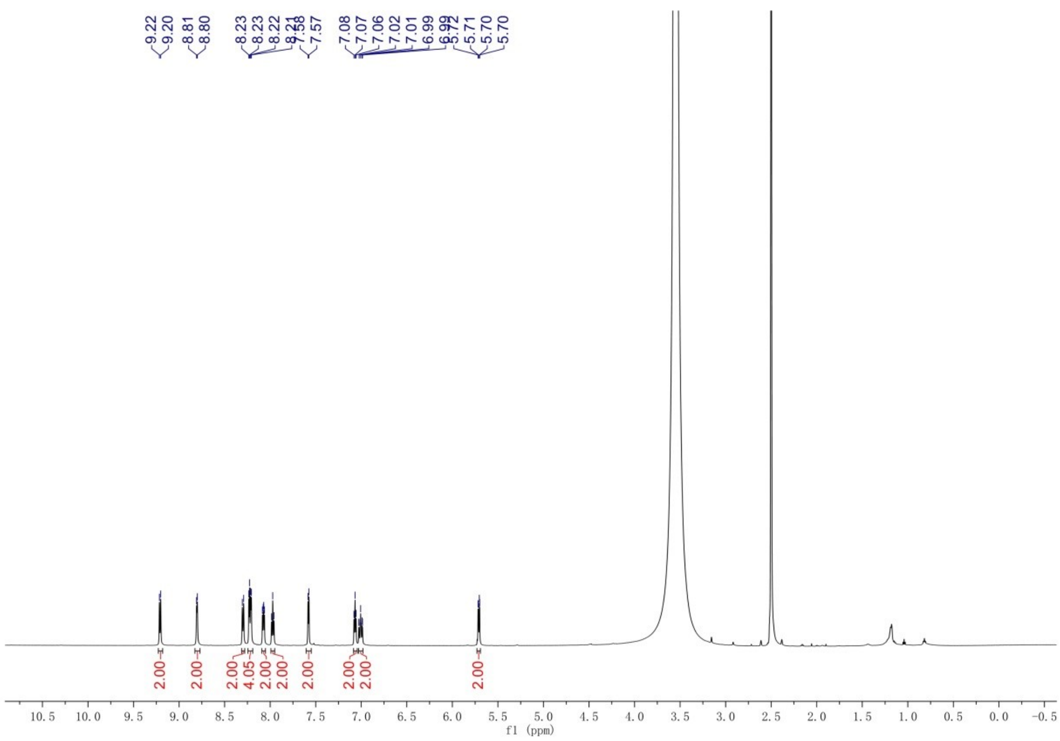


Fig. S9 ^{1}H NMR spectrum of **Ir-3**.

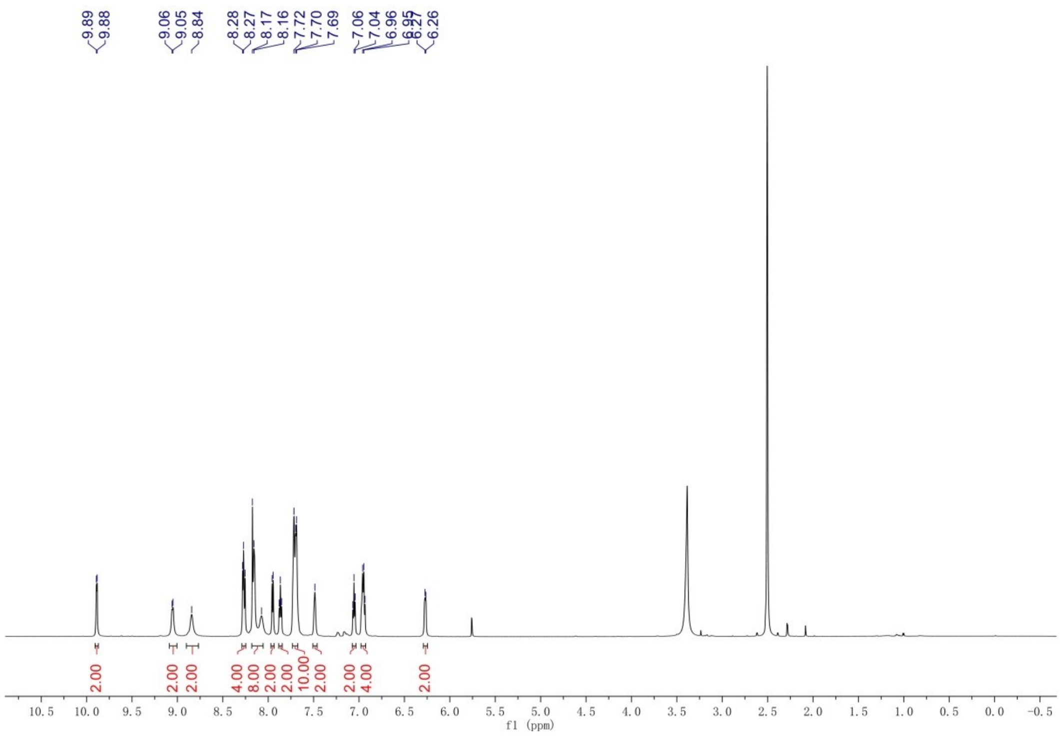


Fig. S10 ^{1}H NMR spectrum of **IrRe-1**.

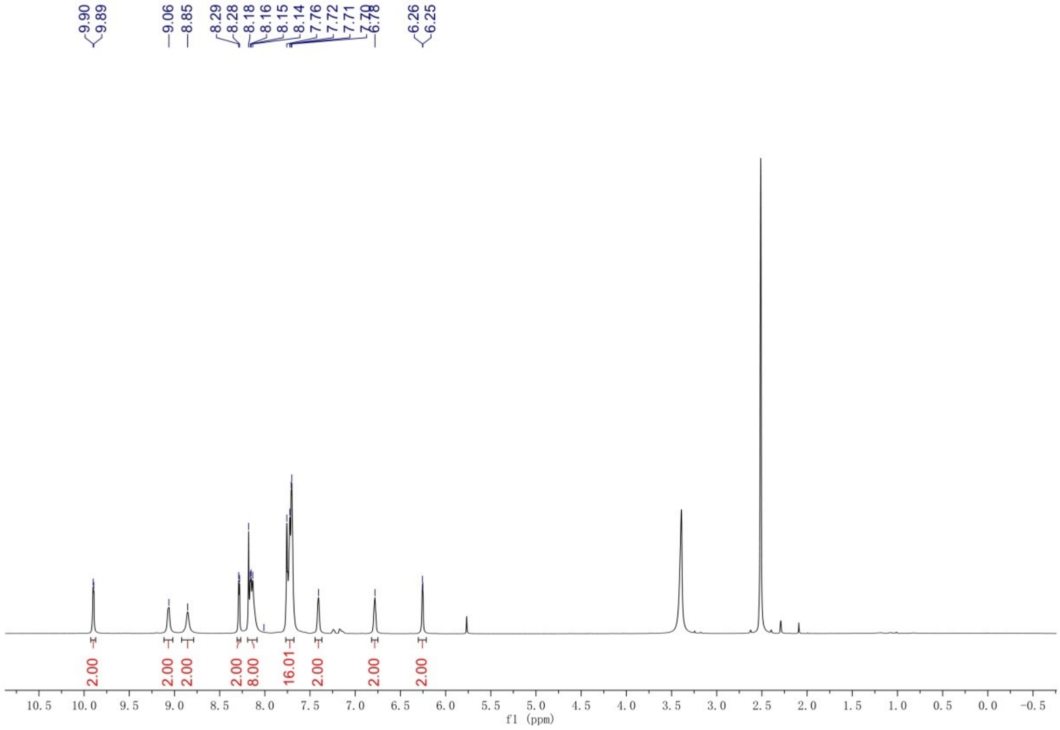


Fig. S11 [1]H NMR spectrum of **IrRe-2**.

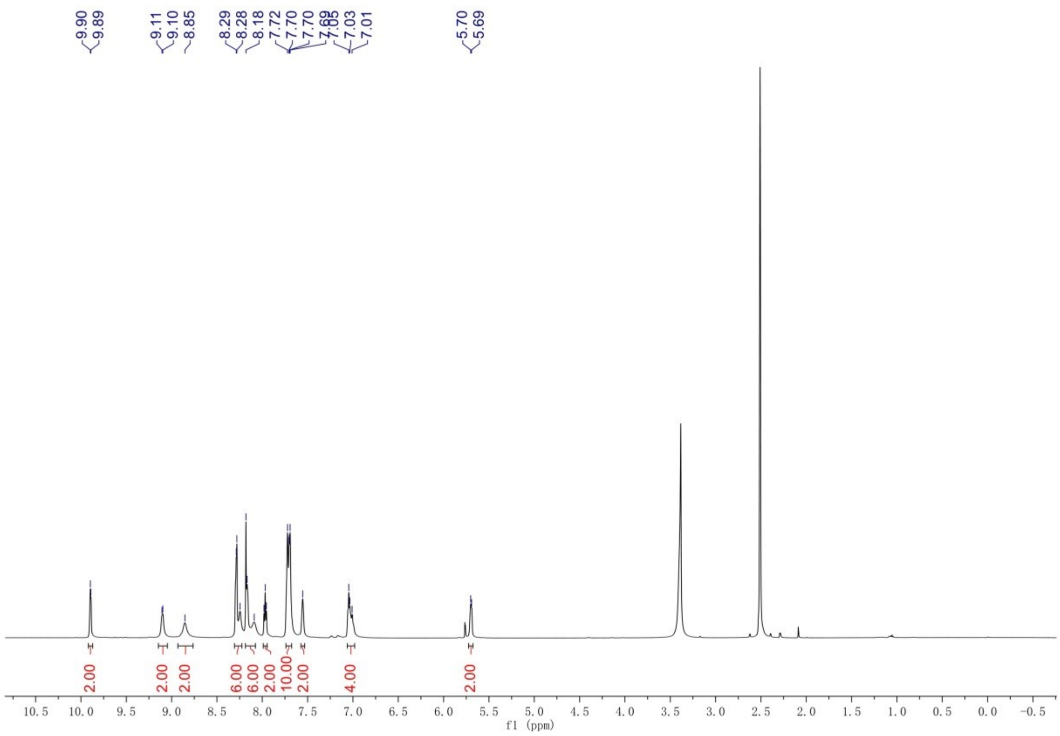


Fig. S12 [1]H NMR spectrum of **IrRe-3**.

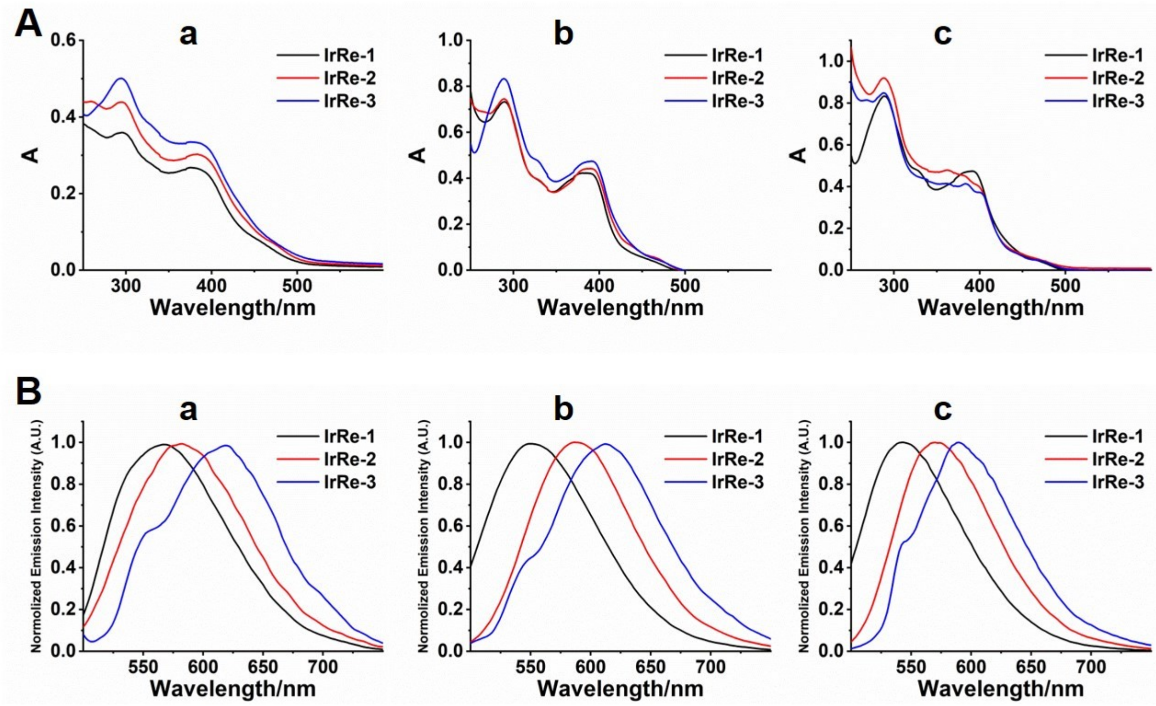


Fig. S13 (A) UV/Vis spectra (1×10^{-5} M) of **IrRe-1–3** measured in PBS (a), CH_3CN (b) and CH_2Cl_2 (c) at 298 K. (B) Emission spectra (1×10^{-5} M) of **IrRe-1–3** measured in PBS (a), CH_3CN (b) and CH_2Cl_2 (c) at 298 K (λ_{ex} = 405 nm).

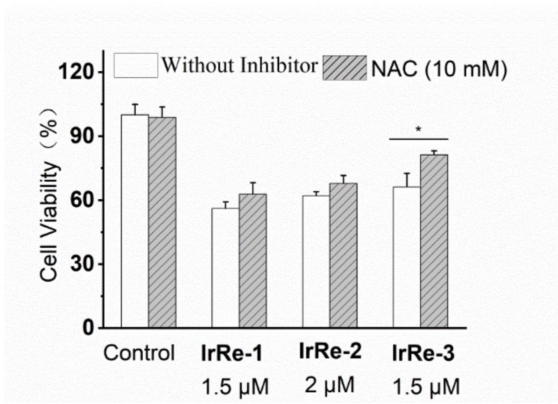


Fig. S14 Cell viability of HeLa cells treated with **IrRe-1–3** in the presence or absence of NAC for 48 h. (* $P < 0.05$, as compared with the group without NAC treatment).

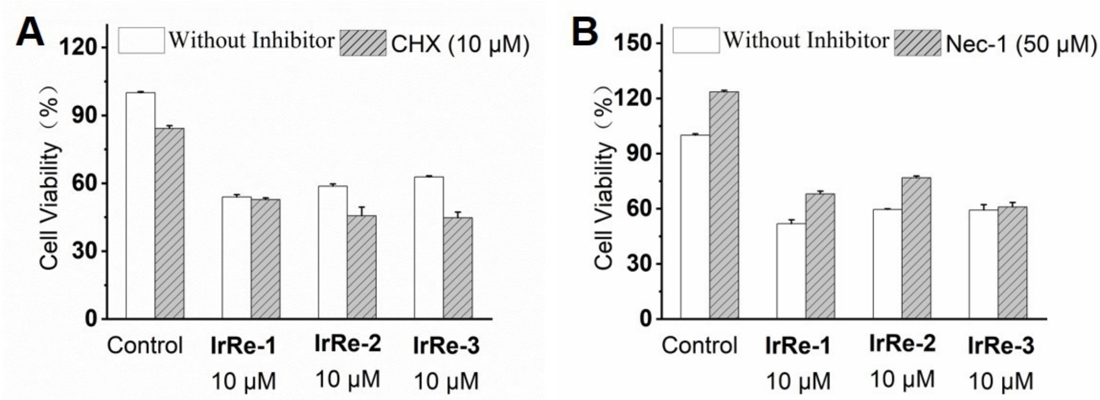


Fig. S15 Cell viability of HeLa treated with **IrRe-1–3** in the presence or absence of CHX (A) or Nec-1 (B) for 24 h.

Table S1 Photophysical data of **IrRe-1–3**

Compounds	Medium	$\lambda_{abs, max}$ (nm)	$\lambda_{em, max}$ (nm)
	PBS	380	568
IrRe-1	CH_3CN	391	570
	CH_2Cl_2	384	540
	PBS	378	576
IrRe-2	CH_3CN	391	576
	CH_2Cl_2	386	572
	PBS	379	607
IrRe-3	CH_3CN	391	610
	CH_2Cl_2	378	590

Table S2 The emission quantum yields of compounds

Compounds	Medium	Φ_{em}[a]
IrRe-1	PBS	0.004
	CH_3CN	0.009
	CH_2Cl_2	0.213
IrRe-2	PBS	0.001
	CH_3CN	0.004
	CH_2Cl_2	0.069
IrRe-3	PBS	0.005
	CH_3CN	0.008
	CH_2Cl_2	0.109
Ir-1	PBS	0.026
	CH_3CN	0.014
	CH_2Cl_2	0.048
Ir-2	PBS	0.003
	CH_3CN	0.007
	CH_2Cl_2	0.017
Ir-3	PBS	0.008
	CH_3CN	0.027
	CH_2Cl_2	0.106
Re-1	PBS	0.108
	CH_3CN	0.193
	CH_2Cl_2	0.291

[a] Solutions of $[Ru(bpy)_3](PF_6)_2$ were used as the standard, PBS (Φ_{em} = 0.042),[1] CH_3CN (Φ_{em} = 0.062)[2] and CH_2Cl_2 (Φ_{em} = 0.059).[3]

Table S3 Cell-cycle analysis data of **IrRe-1–3** on HeLa cells[a]

Compounds	G0/G1	S	G2/M
Control	57.1 ± 3.3	24.5 ± 2.1	18.4 ± 1.2
IrRe-1, 3 μM	59.9 ± 3.2	15.3 ± 2.4	24.8 ± 2.3
IrRe-1, 4.5 μM	66.4 ± 3.1	5.4 ± 1.1	28.2 ± 1.2
IrRe-1, 6 μM	66.6 ± 2.8	4.8 ± 1.2	28.6 ± 1.3
IrRe-2, 4 μM	44.6 ± 3.3	41.0 ± 3.7	14.4 ± 1.7
IrRe-2, 6 μM	61.3 ± 2.9	6.4 ± 1.7	32.3 ± 2.5
IrRe-2, 8 μM	70.7 ± 3.8	10.1 ± 1.9	19.2 ± 3.5
IrRe-3, 3 μM	59.8 ± 1.4	26.1 ± 1.8	13.9 ± 3.9
IrRe-3, 4.5 μM	61.8 ± 3.7	5.3 ± 0.8	32.8 ± 2.3
IrRe-3, 6 μM	82.6 ± 6.3	14.4 ± 1.6	3.0 ± 0.7

[a] Data shown are mean ± SD of three independent experiments for each treatment.

Supporting References

1 J. Van Houten and R. J. Watts, *J. Am. Chem. Soc.*, 1976, **98**, 4853-4858.

2 D. S. Tyson and F. N. Castellano, *J. Phys. Chem. A*, 1999, **103**, 10955-10960.

3 D. Pucci, A. Bellusci, A. Crispini, M. Ghedini, N. Godbert, E. I. Szerb and A. M. Talarico, *J. Mater. Chem.*, 2009, **19**, 7643-7649.