Title:

Broadband 75-85 MHz radiofrequency fields disrupt magnetic compass orientation in night-migratory songbirds consistent with a flavin-based radical pair magnetoreceptor

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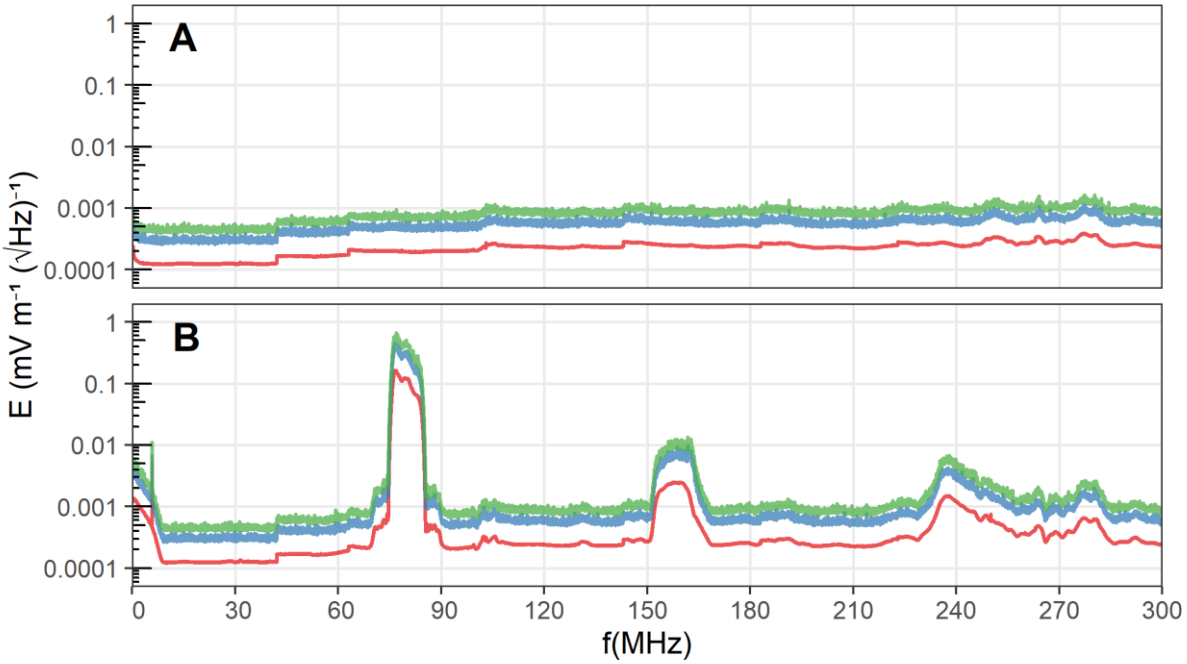

Fig. SI1: Measurements of the electric components of the RF fields measured in the range of 150 kHz to 300 MHz. (A) The control condition and (B) the 75-85 MHz broadband noise used for the "RF" condition. Magnetic component spectra are displayed in Fig. 2 in the main text. Spectral traces: 'average' (lower red line); 'maxhold' (upper blue line). Notice that the electric disturbance spectrum shows harmonic impurities, in contrast to the extremely clean magnetic components in Fig. 2.

Table SI1: Comparative table of different density and intensity measures from (Kobylkov et al. 2019), with measures of present study appended. Species: ER: European robin, BC: Eurasien blackcap. For formulas of $\bar{b}^{\max}$, $\bar{b}$, $B_{\mathrm{rms}}^{\max}$, and B_{rms} see (Kobylkov et al. 2019; equations 2.1 and 2.3). Orientation: behavioural experiments resulted in oriented (+) or disoriented (–) birds.

Frequency band (kHz)	species	$\bar{b}^{\max}$ $(pT\left(\sqrt{Hz}\right)^{-1})$	$\bar{b}$ $(pT\left(\sqrt{Hz}\right)^{-1})$	$B_{\mathrm{rms}}^{\max}$ (nT)	B_{rms} (nT)	orientation	source
10 – 5000	ER	0.07	~0.02	1.18	~0.37	+	Engels et al. 2014 (Fig. 4f, blue trace)
10 – 5000	ER	5.58	~1.8	23.2	~7.35	-	Engels et al. 2014 (Fig. 4f, red trace)
20 – 450	ER	30.1	~9.5	23.1	~7.29	-	Engels et al. 2014 (Fig. 4f, green trace)
600 – 3000	ER	1.35	~0.43	2.3	~0.73	-	Engels et al. 2014 (Fig. 4f, black trace)
0.1 – 100	BC	23.3	6.6	7.98	2.26	+	Kobylkov et al. 2019 (Fig. 1a, RF-on)
0.1 – 100	BC	0.92	0.32	1.29	0.51	+	Kobylkov et al. 2019 (Fig. 1c, RF-off)
75000 – 85000	BC	1.647	0.681	5.615	2.318	-	present study (Fig. 2A, RF)
75000 – 85000	BC	0.01	0.004	0.031	0.013	+	present study (Fig. 2B, Control)

Table SI 2

Experimental result summary for the individual birds in the respective test conditions (NMF: natural magnetic field in Oldenburg; CMF: changed magnetic field, turned by 120° counter-clockwise; suffix "-RF": magnetic field condition with 75-85 MHz broadband RF fields present). For each individual (Ring) the mean orientation (*dir*), and Rayleigh value (*r*) for this orientation, the portions of valid (*valid*), random (*rnd*) and not active (*na*) trials for the overall number of trials (*N*) are listed. Only result with sufficient valid trials and a directed orientation (*valid* ≥ 3; *r* ≥ 0.2) were used for the final statistics and diagrams.

	NMF						CMF						NMF-RF						CMF-RF						
Ring	dir	r	valid	rnd	na	N	dir	r	valid	rnd	na	N	dir	r	valid	rnd	na	N	dir	r	valid	rnd	na	N	Year
11 white/grey	21.09	0.42	6	1	1	8	353.11	0.39	5	0	0	5	73.21	0.83	5	2	1	8	351.70	0.51	3	0	2	5	2019
15 blue	30.57	0.91	3	2	1	6	235.76	0.29	5	0	0	5	80.00	0.76	3	0	3	6	296.89	0.28	3	0	3	6	2019
17 grey	123.79	0.36	3	1	1	5	84.03	0.25	3	0	3	6	70.00	1.00	1	2	2	5	180.00	0.64	2	1	3	6	2019
19 blue	304.87	0.20	3	1	2	6	219.36	0.30	3	1	2	6	187.63	0.73	3	2	1	6	138.95	0.84	3	0	3	6	2019
19 grey	12.93	0.80	3	1	1	5	311.33	0.65	5	0	0	5	224.76	0.27	4	0	2	6	230.00	1.00	1	1	5	7	2019
22 grey	90.00	0.91	3	1	4	8	258.44	0.41	3	2	1	6	271.44	0.80	3	1	4	8	86.78	0.48	3	0	3	6	2019
27 blue	203.91	0.15	4	3	0	7	301.79	0.27	4	1	0	5	73.59	0.40	7	0	0	7	301.97	0.22	5	0	0	5	2019
31 green	43.07	0.84	3	4	1	8	10.16	0.95	5	0	0	5	275.00	0.77	2	2	4	8	138.47	0.38	4	0	2	6	2019
32 grey	97.00	0.92	3	1	4	8	125.00	1.00	2	2	4	8	185.00	0.82	2	4	2	8	2.50	0.53	3	2	3	8	2019
33 grey	19.56	0.28	3	1	1	5	34.88	0.32	3	1	2	6	320.00	0.33	3	0	2	5	178.92	0.44	4	0	2	6	2019
34 orange/black	208.55	0.70	4	2	1	7	255.51	0.86	3	1	1	5	134.02	0.49	4	3	0	7	135.00	1.00	1	2	3	6	2019
40 grey/white	82.16	0.37	4	1	1	6	182.90	0.17	4	1	3	8	125.00	0.09	2	1	4	7	219.28	0.68	5	0	3	8	2019
45 blue	285.00	0.98	2	7	1	10	335.81	0.44	5	0	0	5	324.39	0.47	8	2	0	10	217.54	0.31	5	1	0	6	2019
47 blue	275.00	0.71	2	1	1	4	152.50	0.92	2	1	4	7	101.87	0.37	4	0	1	5	299.60	0.86	3	2	2	7	2019
49 blue	66.43	0.67	3	1	3	7	41.99	0.53	4	1	1	6	238.40	0.48	3	0	4	7	230.93	0.68	3	1	2	6	2019
58 blue	356.52	0.35	3	2	4	9	315.00	0.38	3	1	1	5	342.50	0.54	2	3	4	9	140.00	0.34	2	1	4	7	2019
64 blue	261.26	0.24	5	0	2	7	123.06	0.52	3	1	3	7	232.50	0.99	2	1	4	7	18.91	0.50	5	0	2	7	2019
67 orange	73.19	0.20	6	2	1	9	4.56	0.31	5	1	0	6	301.00	0.04	8	1	0	9	157.50	0.13	2	4	0	6	2019
79 green	174.54	0.53	4	2	3	9	319.80	0.92	3	1	2	6	30.00	0.50	2	6	1	9	137.50	0.92	2	2	3	7	2019
81 green	72.66	0.46	3	2	0	5	359.45	0.40	5	0	0	5	196.94	0.52	3	3	0	6	3.30	0.49	5	0	0	5	2019
19 violet	228.60	0.05	14	2	0	16	163.06	0.05	14	2	0	16	110.55	0.33	7	1	0	8	151.74	0.41	8	0	0	8	2021
23 yellow	164.75	0.48	9	0	1	10	253.27	0.24	11	0	1	12	307.85	0.16	7	0	1	8	335.73	0.20	12	0	0	12	2021
36 violet	81.80	0.20	10	1	3	14	311.98	0.21	12	2	0	14	260.84	0.26	7	0	1	8	172.20	0.31	8	1	1	10	2021
41 violet	164.17	0.45	7	0	3	10	205.63	0.43	6	0	3	9	168.22	0.21	5	0	3	8	217.61	0.32	8	0	6	14	2021
43 violet	152.17	0.45	8	1	1	10	298.95	0.28	6	2	0	8	98.47	0.28	9	3	2	14	215.94	0.11	15	1	2	18	2021
47 yellow	98.73	0.28	4	0	0	4	144.94	0.24	6	0	1	7	187.50	0.23	4	0	0	4	117.84	0.20	4	0	0	4	2021
55 yellow	124.30	0.39	7	1	0	8	348.88	0.30	12	0	0	12	37.39	0.37	6	1	0	7	285.11	0.23	12	0	0	12	2021
58 red	34.57	0.52	5	3	0	8	307.34	0.34	6	2	0	8	35.67	0.22	7	3	0	10	25.99	0.28	5	4	1	10	2021
59 red	58.99	0.40	5	1	0	6	241.77	0.49	5	5	0	10	279.11	0.32	5	5	0	10	28.88	0.26	5	4	1	10	2021
62 orange	200.08	0.32	9	1	0	10	19.45	0.15	12	2	0	14	293.51	0.30	7	1	0	8	117.13	0.54	8	0	0	8	2021
71 violet	158.21	0.58	5	1	0	6	345.04	0.08	12	1	2	15	190.00	0.04	4	0	0	4	66.16	0.40	7	0	1	8	2021
72 violet	95.17	0.82	3	1	6	10	325.00	0.43	3	1	4	8	141.39	0.36	3	0	3	6	240.44	0.28	3	0	7	10	2021
74 violet	347.64	0.15	13	0	1	14	205.06	0.50	9	0	1	10	281.23	0.45	8	0	0	8	153.14	0.18	13	1	2	16	2021
76 violet	337.54	0.23	4	0	0	14	345.86	0.23	5	0	8	13	94.63	0.53	5	1	4	10	71.15	0.37	5	0	5	10	2021
77 violet	305.32	0.36	8	0	2	10	208.05	0.32	9	0	4	13	65.00	0.20	5	1	4	10	53.22	0.47	5	0	5	10	2021
82 violet	78.20	0.71	5	3	2	10	335.36	0.45	7	1	0	8	154.64	0.39	6	1	3	10	154.57	0.40	7	3	0	10	2021
86 violet	356.29	0.63	5	0	3	8	213.10	0.20	8	0	6	14	303.56	0.30	6	0	4	10	22.47	0.23	7	0	1	8	2021