## Gyromagnetic Imaging: Dynamic Optical Contrast Using Gold Nanostars With Magnetic Cores (Supporting Information)

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**Movie S1.** Polarized scattering response ( $\lambda_{ex} > 650 \text{ nm}$ ) of nanostars gyrating at 4.8 Hz, with  $2\omega$  modulation. Real-time images recorded at 120 fps.

**Movie S2.** 3D rendering of nanostars gyrating at 4.8 Hz, to illustrate temporal modulations in scattering intensities with fixed lateral positions.



**Figure S1.** Signal-to-noise ratios (SNRs) of 2 $\omega$  frequency response in power spectra of gyromagnetic nanostars on glass slide (*N*=108), using a polarized broadband excitation source with a longpass filter ( $\lambda_{ex} > 650$  nm) and a rotating magnetic field gradient (|H| = 80 Oe,  $\omega = 4.8$  Hz). Detection threshold (SNR=2.5) marked by dashed line.



**Figure S2.** Representative power spectra of gyromagnetic nanostars on glass slide (see Table S1 for full listing). (a)  $2\omega$ -selective response (Nanostar # 26); (b) bimodal  $\omega$ - and  $2\omega$  response (Nanostar #40); (c)  $2\omega$  response with higher harmonics (Nanostar #46).



Scheme S1. Layout of optical instrumentation for polarized darkfield microscopy (epiillumination, total internal reflectance) and gyromagnetic imaging. An overhead stirring motor (decoupled from the microscope stage) operating at rotation speeds between 2.5 and 4.8 rps (Hz) is centered over the sample. Nanostars are selectively illuminated using 780-nm laser light (solid beam). For low-contrast conditions, the optical path can be switched to allow for white light illumination through a longpass filter (dashed beam,  $\lambda$ >650 nm)). F=filter; L=condensor lens; M=mirror; P=polarizer plate; PB=polarized beamsplitter.

	SNR			SNR			SNR		
No.	ω	2ω	No.	ω	2ω	No.	ω	2ω	
1	7.67	61.9	41	13.4	7.00	81	1.04	20.8	
2	2.68	22.5	42	5.05	1.55	82	1.76	26.7	
3	1.13	0.44	43	67.3	6.43	83	2.44	32.2	
4	1.77	27.7	44	53.1	3.87	84	2.43	52.8	
5	1.73	7.32	45	2.97	15.8	85	1.95	14.9	
6	1.68	18.2	46	6.94	17.7	86	2.86	20.0	
7	0.96	7.10	47	30.9	20.6	87	1.30	22.0	
8	1.18	7.57	48	53.7	40.2	88	1.84	18.2	
9	2.22	7.77	49	20.2	21.0	89	1.24	51.9	
10	1.70	12.6	50	34.3	16.2	90	1.82	3.28	
11	1.99	4.54	51	23.1	50.2	91	0.96	9.63	
12	2.10	14.8	52	22.1	41.9	92	1.78	5.78	
13	2.33	14.5	53	14.6	29.4	93	2.20	5.65	
14	3.44	16.6	54	21.7	29.0	94	2.43	2.99	
15	2.22	5.48	55	4.82	10.5	95	11.7	6.12	
16	1.04	3.51	56	12.3	2.30	96	2.14	3.58	
17	1.94	4.73	57	2.21	0.63	97	0.86	2.78	
18	1.69	10.0	58	2.74	3.11	98	2.93	2.13	
19	1.31	6.72	59	1.15	2.87	99	1.47	4.63	
20	2.33	4.09	60	2.01	2.27	100	1.47	13.7	
21	3.41	3.07	61	4.72	14.4	101	1.99	4.17	
22	1.74	4.29	62	12.2	8.05	102	3.09	11.1	
23	1.81	10.7	63	23.3	11.0	103	4.20	2.84	
24	1.67	15.3	64	5.17	11.4	104	0.89	3.44	
25	2.37	7.80	65	9.89	20.8	105	3.46	2.82	
26	1.37	23.8	66	18.5	7.44	106	3.54	2.89	
27	1.69	2.74	67	17.4	13.7	107	2.53	7.25	
28	3.95	9.80	68	16.4	23.9	108	1.58	1.59	
29	4.17	12.7	69	41.7	22.5				
30	0.91	2.97	70	17.9	11.8				
31	2.02	2.06	71	24.5	29.2				
32	3.09	7.74	72	17.5	9.32				
33	2.00	8.01	73	1.00	9.62				
34	0.91	5.85	74	0.85	30.3				
35	2.06	8.27	75	3.18	10.4				
36	2.37	4.60	76	1.52	24.2				
37	1.37	5.42	77	2.37	5.01				
38	31.8	308	78	1.32	43.9				
39	6.13	10.6	79	2.33	25.2				
40	17.6	125	80	1.45	29.1				

**Table 1**. SNR values of  $\omega$  and  $2\omega$  response of gyromagnetic nanostars on glass slide (*N*=108).