

```
1 begin
2   import Pkg
3   Pkg.activate(".")
4   using CairoMakie, DrWatson,
5     DataFramesMeta, Statistics, PlutoUI,
      Colors
end
```

```
Activating project at `~/Documents/PhD/my-papers/2023-cTWA-Javad/DiscreteCTWAPaper/notebooks`
```

```
1 html"""
2 <style>
3 main { max-width: 60%}
4 </style>
5 """
```

Table of Contents

Style

Section 1&2

Load data

Fig. 3 Magnetization $f=10\%$

Fig. 4 Magnetization $f=50\%$

Fig. 6: Renyi2 $f=10\%$

Fig. 7 Renyi2 $f=50\%$

Fig. 8: XXZ Magnetization $f=10\%$, $\alpha=0.5$

Fig. 9: XXZ Magnetization $f=10\%$, $\alpha=6$

Fig. 10: XXZ Renyi $f=10\%$, $\alpha=0.5$

Fig. 11: XXZ Renyi $f=10\%$, $\alpha=6$

Section 1: ordered

Fig. 5 Magnetization/Renyi ordered

Section 3: Statistics

Fig. 12: Stddev of magnetization

eomdrop (generic function with 1 method)

```
1 begin
2     eom(A;dims) = std(A;dims) ./ √(reduce(*,
3     size(A,d) for d in dims))
4     meandrop(A;dims) =
5     dropdims(mean(A;dims);dims)
6     stddrop(A;dims) =
7     dropdims(std(A;dims);dims)
8     eomdrop(A;dims) =
9     dropdims(eom(A;dims);dims)
10
11 end
```

save_and_display (generic function with 3 methods)

```
1 begin
2     function save_and_display(name,
3     folder="./plots")
4         return fig -> save_and_display(name,
5         fig, folder)
6     end
7     function save_and_display(name, fig,
8     folder)
9         mkpath(folder)
10        mkpath(joinpath(folder, "png"))
11        Makie.save(joinpath(folder,
12        name*".pdf"), fig)
13        Makie.save(joinpath(folder, "png",
14        name*".png"), fig)
15        fig
16    end
17 end
```


Style

HEIGHT = 250

```
1 HEIGHT = 250
```

SCALE = 2

```
1 SCALE = 2
```

bgcolor =

```
1 bgcolor = RGBf(1,1,1)
```

THEME =

Attributes with 8 entries:

Axis => Attributes with 4 entries:

backgroundcolor => RGB{Float32}(1.0,1.0,1.0)

xscale => identity

xtickalign => 1

ytickalign => 1

figure_padding => (1, 7, 1, 1)

fonts => Attributes with 4 entries:

bold => FTFont (family = NewComputerModern, s

bolditalic => FTFont (family = NewComputerMod

italic => FTFont (family = NewComputerModern,

regular => FTFont (family = NewComputerModern

fontsize => 18

Label => Attributes with 3 entries:

font => bold

halign => left

valign => top

Legend => Attributes with 1 entry:

backgroundcolor => RGB{Float32}(1.0,1.0,1.0)

pt_per_unit => 0.5

size => (492, 500)

```
1 THEME = merge(theme_latexfonts(),
2     Theme(fontsize=9*SCALE,
3     size=(246*SCALE,HEIGHT*SCALE),
4     pt_per_unit=1/SCALE,
5     figure_padding=(1,7,1,1),
6     Axis=(; xtickalign=1, ytickalign=1,
7     xscale=identity,
8     backgroundcolor=bgcolor),
    Legend=(; backgroundcolor=bgcolor),
    Label=(; font=:bold,
    halign=:left, valign=:top)))
```

section1_palette =

(dTWA = , rg_dcTWA = , ed = )

```
1 # section1_palette = (  
2 #   dTWA = Makie.wong_colors()[1],  
3 #   rg_dcTWA = Makie.wong_colors()[7],  
4 #   ed = RGBAf(0,0,0),  
5 #   rg_gcTWA = Makie.wong_colors()[3],  
6 #   naive_gcTWA = Makie.RGBf(0.9,0.3,0.7))  
7 section1_palette = (  
8   dTWA = brini[2],  
9   rg_dcTWA = brini[5],  
10  ed = brini[3],  
11  rg_gcTWA = brini[4],  
12  naive_gcTWA = brini[1])
```

to_color (generic function with 1 method)

```
1 to_color(r,g,b) = RGBf(r/255,g/255,b/255)
```

brini =



```
1 brini = [to_color(29, 59, 181),  
  to_color(220, 171, 67), to_color(51, 51,  
  51), to_color(119, 188, 101), to_color(135,  
  78, 189)]
```


Section 1&2

Load data

```
1 df_raw = collect_results("../data/  
simulations");
```

Scanning folder ../data/simulations for
result files.

Added 1092 entries.

df_avg =

	clustersize	N	α	Δ	tlis
1	missing	16	0.5	0	0.0:0.2
2	missing	16	1.0	0	0.0:0.2
3	missing	16	3.0	0	0.0:0.2
4	missing	16	6.0	0	0.0:0.2
5	missing	16	0.5	2	0.0:0.2
6	missing	16	6.0	2	0.0:0.2
7	missing	16	0.5	4	0.0:0.2
8	missing	16	6.0	4	0.0:0.2
9	missing	16	1.0	2	0.0:0.2
10	missing	16	3.0	2	0.0:0.2
more					
116	4	16	3.0	0	0.0:0.0


```

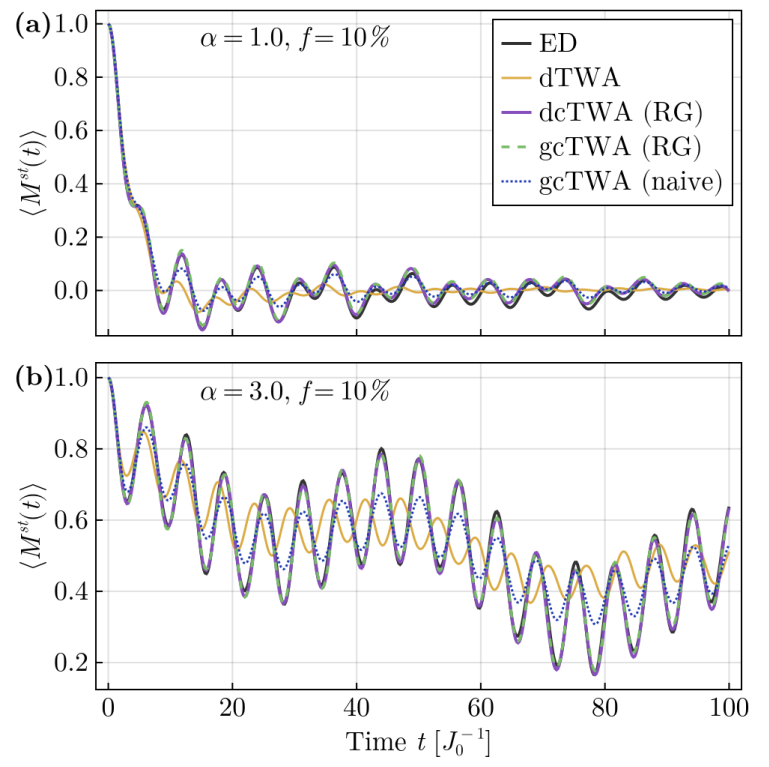
1 df_avg = @chain df_raw begin
2     groupby([:clustersize, :N, :α, :Δ,
3             :tlist, :alg, :filling, :clustering])
4     @combine(
5         :magnetization_mean =
6         Ref(mapreduce(x->getproperty.(x,
7             Ref(Symbol("magnetization_mean"))),
8             vcat, :results)),
9         :magnetization_eom = Ref(mapreduce(x->
10             getproperty.(x,
11             Ref(Symbol("magnetization_eom"))),
12             vcat, :results)),
13         :pair_renyi2 = Ref(mapreduce(x->
14             getproperty.(x,
15             Ref(Symbol("pair_renyi2"))), vcat,
16             :results)))
17     @rtransform(
18         :nshots =
19         length(:magnetization_mean),
20         :magnetization_mean =
21         meandrop(stack(:magnetization_mean);
22             dims=2),
23         :magnetization_eom_stat =
24         eomdrop(stack(:magnetization_mean);
25             dims=2),
26         :magnetization_eom_syst = sqrt.
27         (meandrop(stack(:magnetization_eom)
28             .^ 2; dims=2)),
29         :pair_renyi2_mean =
30         meandrop(stack(:pair_renyi2);
31             dims=2),
32         :pair_renyi2_eom =
33         eomdrop(stack(:pair_renyi2); dims=2))
34     @rtransform(
35         :magnetization_eom_full = hypot.
36         (:magnetization_eom_stat,
37         :magnetization_eom_syst))
38     select!
39     (Not([:pair_renyi2, :magnetization_eom]))
40 end

```

make_plot_section12! (generic function with 1 metl

```
1 function make_plot_section12!(ax, data,
2 mean, error; colors=section1_palette)
3     dTWA, rg_dcTWA, naive_dcTWA, ed,
4     rg_gcTWA, naive_gcTWA =
5     eachrow(sort(data, [:alg, :clustering]))
6     lines!(ax, ed.tlist, ed[mean];
7     color=colors.ed, linewidth=2, label="ED")
8     lines!(ax, dTWA.tlist, dTWA[mean];
9     color=colors.dTWA, label="dTWA")
10    lines!(ax, rg_dcTWA.tlist,
11    rg_dcTWA[mean]; color=colors.rg_dcTWA,
12    label="dcTWA (RG)", linewidth=2)
13    lines!(ax, rg_gcTWA.tlist,
14    rg_gcTWA[mean]; color=colors.rg_gcTWA,
15    linestyle=:dash, label="gcTWA (RG)",
16    linewidth=1.8)
17    lines!(ax, naive_gcTWA.tlist,
18    naive_gcTWA[mean];
19    color=colors.naive_gcTWA,
20    linestyle=Linestyle([0.0,1.0,2.0]),
21    label="gcTWA (naive)")
22 end
```

Fig. 3 Magnetization $f=10\%$



```

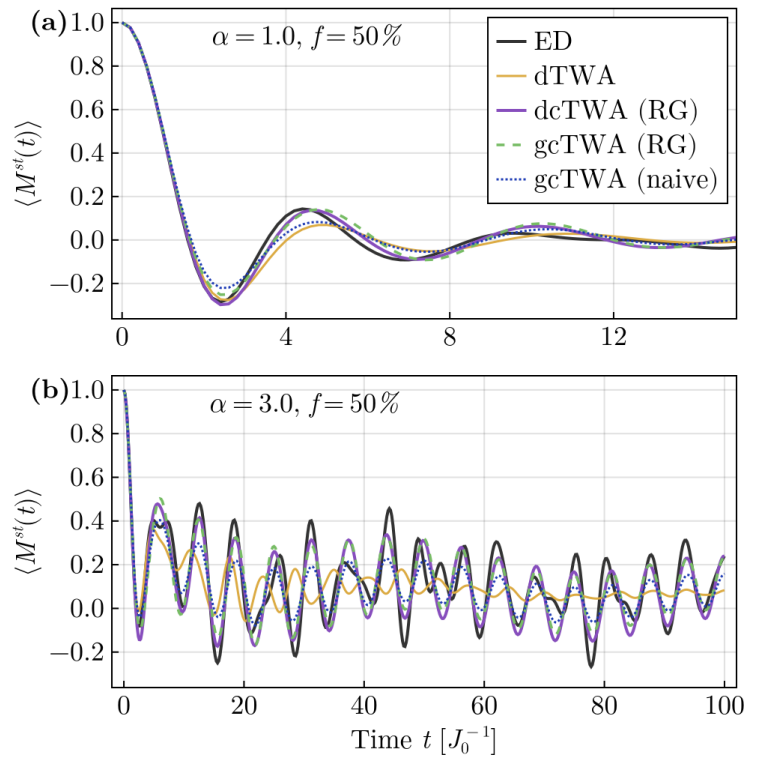
1 with_theme(THEME) do
2     let fig = Figure(),
3         ax1 = Axis(fig[1,1];
4             ylabel=L"\langl e M^{\text{st}}(t)\rangle"
5             make_plot_section12!(ax1,
6                 @rsubset(df_avg, :α == 1,
7                     :filling == 0.1, :Δ == 0),
8                     :magnetization_mean,
9                     :magnetization_eom_full)
10            ax2 = Axis(fig[2,1]; xlabel=L"Time
11                $t$ $[J_0^{-1}]$", ylabel=L"\langl e
12                M^{\text{st}}(t)\rangle"
13            make_plot_section12!(ax2,
14                @rsubset(df_avg, :α == 3,
15                    :filling == 0.1, :Δ == 0),
16                    :magnetization_mean,
17                    :magnetization_eom_full)
18            xlims!([ax1, ax2], -2, 102)
19            ylims!(ax1, -0.17, 1.05)
20            ax1.xticks = 0:20:100
21            ax2.xticks = 0:20:100
22            ax1.yticks = -1:0.2:1
23            ax2.yticks = -1:0.2:1
24            ax1.xticklabelsvisible = false
25            #Legend(fig[3,1], ax; )
26            axislegend(ax1; position=:rt)
27            text!(ax1, 30.0, 1.0;
28                text=L"\alpha=1.0, \ f=10%",
29                align=(:center, :top))
30            text!(ax2, 30.0, 1.0;
31                text=L"\alpha=3.0, \ f=10%",
32                align=(:center, :top))

33            Label(fig[1,1]; text="(a)",
34                tellwidth=false, tellheight=false,
35                alignmode=Mixed(;left=-55, bottom=6))
36            Label(fig[2,1]; text="(b)",
37                tellwidth=false, tellheight=false,
38                alignmode=Mixed(;left=-55, bottom=6))

39            fig
40        end
41    end |> save_and_display("fig3")

```

**Fig. 4 Magnetization
f=50%**

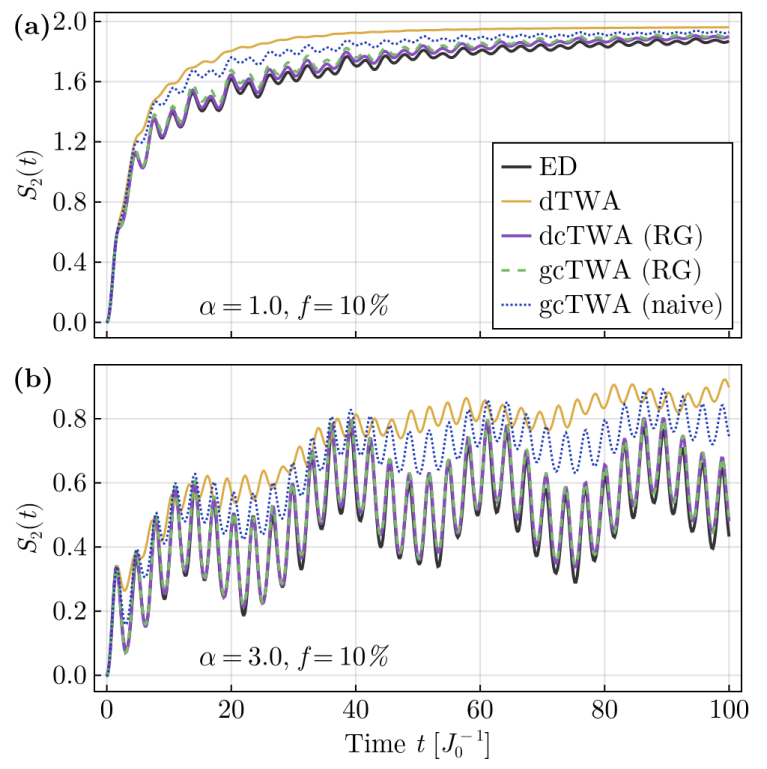


```

1 with_theme(THEME) do
2     let fig = Figure(),
3         ax1 = Axis(fig[1,1];
4             ylabel=L"\langle M^{st}(t)\rangle"
5             make_plot_section12!(ax1,
6                 @rsubset(df_avg, :α == 1,
7                     :filling == 0.5, :Δ == 0),
8                     :magnetization_mean,
9                     :magnetization_eom_full)
10            ax2 = Axis(fig[2,1]; xlabel=L"Time
11            $t$ $[J_0^{-1}]$", ylabel=L"\langle M^{st}(t)\rangle"
12            make_plot_section12!(ax2,
13                @rsubset(df_avg, :α == 3,
14                    :filling == 0.5, :Δ == 0),
15                    :magnetization_mean,
16                    :magnetization_eom_full)
17            xlims!(ax1, -0.25, 15)
18            ax1.xticks = 0:4:20
19            ax1.yticks = -0.2:0.2:1
20
21            xlims!(ax2,-2, 102)
22            ax2.xticks = 0:20:100
23            ax2.yticks = -0.2:0.2:1
24            linkyaxes!(ax1,ax2)
25
26            axislegend(ax1; position=:rt)
27            text!(ax1, 4.5, 1.0;
28                text=L"\alpha=1.0,\ f=50%",
29                align=(:center,:top))
30            text!(ax2, 30.0, 1.0;
31                text=L"\alpha=3.0,\ f=50%",
32                align=(:center,:top))
33
34            Label(fig[1,1]; text="(a)",
35                tellwidth=false, tellheight=false,
36                alignmode=Mixed(;left=-55, bottom=6))
37            Label(fig[2,1]; text="(b)",
38                tellwidth=false, tellheight=false,
39                alignmode=Mixed(;left=-55, bottom=6))
40
41            fig
42        end
43    end |> save_and_display("fig4")

```

Fig. 6: Renyi2 f=10%



```

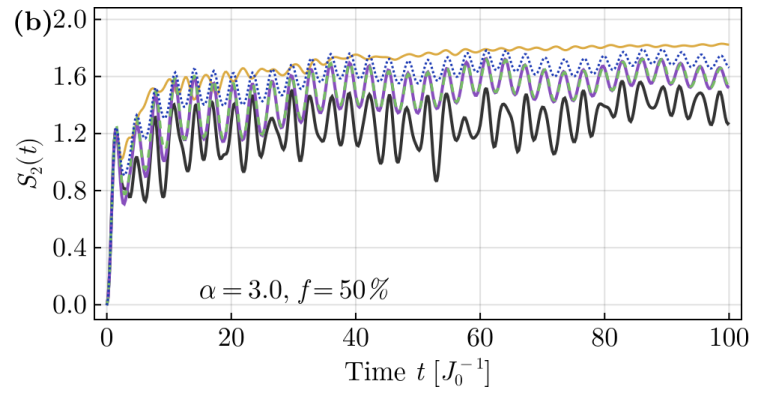
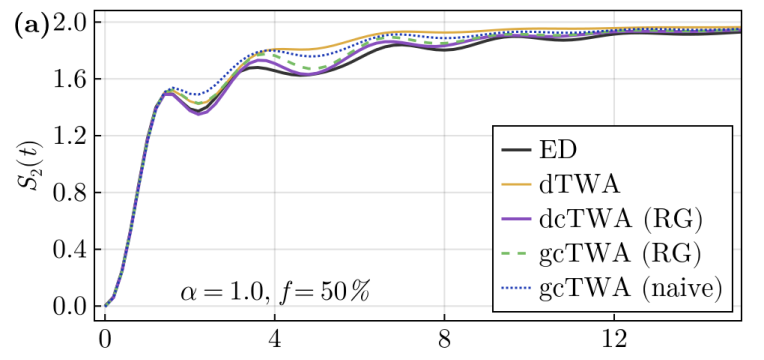
1 with_theme(THEME) do
2     let fig = Figure(),
3         ax1 = Axis(fig[1,1]; ylabel=L"S_{2}"
4             (t))
5         make_plot_section12!(ax1,
6             @rsubset(df_avg, :α == 1,
7                 :filling == 0.1, :Δ == 0),
8                 :pair_renyi2_mean,
9                 :pair_renyi2_eom)
10        ax2 = Axis(fig[2,1]; xlabel=L"Time
11            $t$ $[J_0^{-1}]$", ylabel=L"S_{2}"
12            (t))
13        make_plot_section12!(ax2,
14            @rsubset(df_avg, :α == 3,
15                :filling == 0.1, :Δ == 0),
16                :pair_renyi2_mean,
17                :pair_renyi2_eom)
18        xlims!([ax1, ax2], -2, 102)
19        #ylim!(ax1, -0.17, 1.05)
20        ax1.xticks = 0:20:100
21        ax2.xticks = 0:20:100
22        ax1.yticks = -0:0.4:2
23        ax2.yticks = -1:0.2:2
24        ax1.xticklabelsvisible = false
25        #Legend(fig[3,1], ax; )
26        axislegend(ax1; position=:rb)
27        text!(ax1, 30.0, 0.2;
28            text=L"\alpha=1.0,\ f=10%",
29            align=(:center,:top))
30        text!(ax2, 30.0, 0.1;
31            text=L"\alpha=3.0,\ f=10%",
32            align=(:center,:top))

33        Label(fig[1,1]; text="(a)",
34            tellwidth=false, tellheight=false,
35            alignmode=Mixed(;left=-55, bottom=6))
36        Label(fig[2,1]; text="(b)",
37            tellwidth=false, tellheight=false,
38            alignmode=Mixed(;left=-55, bottom=6))

39        fig
40    end
41end |> save_and_display("fig6")

```

Fig. 7 Renyi2 f=50%

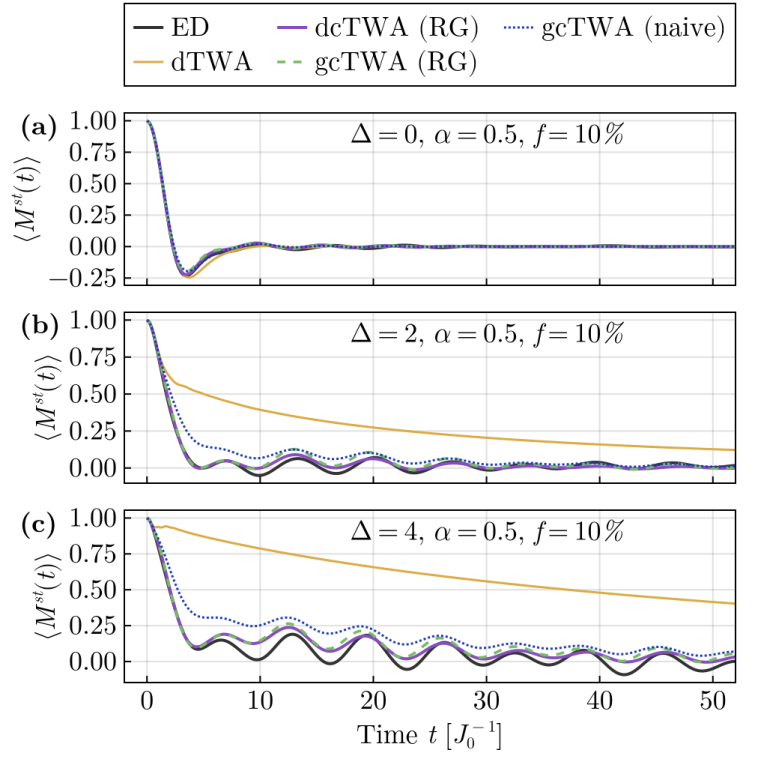


```

1 with_theme(THEME) do
2     let fig = Figure(),
3         ax1 = Axis(fig[1,1]; ylabel=L"S_{2}"
4             (t))
5         make_plot_section12!(ax1,
6             @rsubset(df_avg, :α == 1,
7                 :filling == 0.5, :Δ == 0),
8                 :pair_renyi2_mean,
9                 :pair_renyi2_eom)
10        ax2 = Axis(fig[2,1]; xlabel=L"Time
11            $t$ $[J_0^{-1}]$", ylabel=L"S_{2}"
12            (t))
13        make_plot_section12!(ax2,
14            @rsubset(df_avg, :α == 3,
15                :filling == 0.5, :Δ == 0),
16                :pair_renyi2_mean,
17                :pair_renyi2_eom)
18
19        xlims!(ax1, -0.25, 15)
20        ax1.xticks = 0:4:20
21        ax1.yticks = 0:0.4:2
22
23        xlims!(ax2, -2, 102)
24        ax2.xticks = 0:20:100
25        ax2.yticks = 0:0.4:2
26        linkyaxes!(ax1, ax2)
27
28        #ax1.xticklabelsvisible = false
29
30        axislegend(ax1; position=:rb)
31        text!(ax1, 4.0, 0.2;
32            text=L"\alpha=1.0, \ f=50%",
33            align=(:center, :top))
34        text!(ax2, 30.0, 0.2;
35            text=L"\alpha=3.0, \ f=50%",
36            align=(:center, :top))
37
38        Label(fig[1,1]; text="(a)",
39            tellwidth=false, tellheight=false,
40            alignmode=Mixed(;left=-55, bottom=6))
41        Label(fig[2,1]; text="(b)",
42            tellwidth=false, tellheight=false,
43            alignmode=Mixed(;left=-55, bottom=6))
44
45        fig
46    end
47end |> save_and_display("fig7")

```

**Fig. 8: XXZ Magnetization
f=10%, α=0.5**



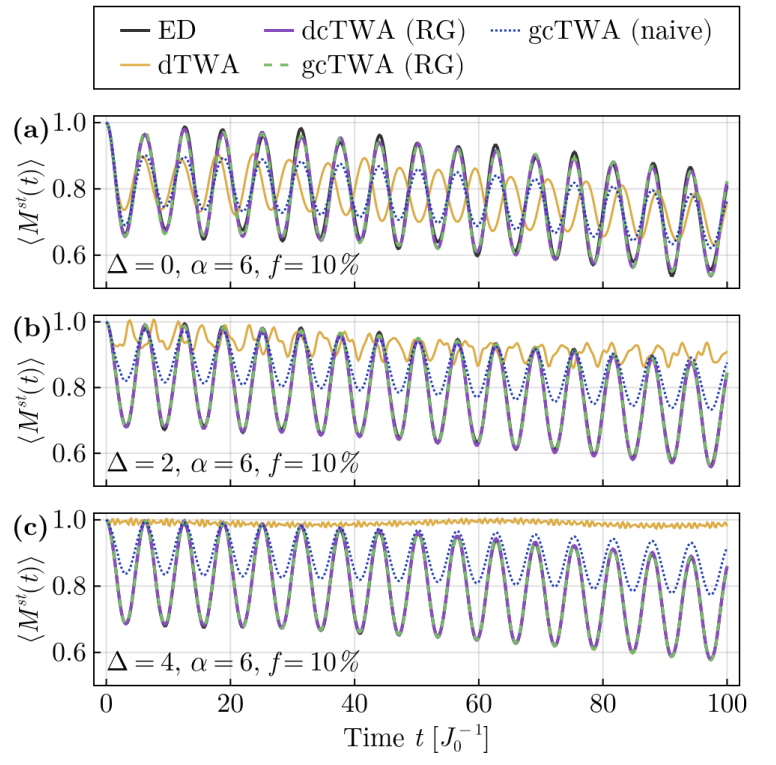
```

1 with_theme(THEME) do
2     let fig = Figure(),
3         ax1 = Axis(fig[1,1];
4             ylabel=L"\langle M^{st}(t)\rangle"
5             make_plot_section12!(ax1,
6                 @rsubset(df_avg, :α == 0.5,
7                     :filling == 0.1, :Δ == 0),
8                     :magnetization_mean,
9                     :magnetization_eom_full)
10        ax2 = Axis(fig[2,1];
11            ylabel=L"\langle M^{st}(t)\rangle"
12            make_plot_section12!(ax2,
13                @rsubset(df_avg, :α == 0.5,
14                    :filling == 0.1, :Δ == 2),
15                    :magnetization_mean,
16                    :magnetization_eom_full)
17        ax3 = Axis(fig[3,1]; xlabel=L"Time
18            $t$ $[J_0^{-1}]$", ylabel=L"\langle M^{st}(t)\rangle"
19            make_plot_section12!(ax3,
20                @rsubset(df_avg, :α == 0.5,
21                    :filling == 0.1, :Δ == 4),
22                    :magnetization_mean,
23                    :magnetization_eom_full)
24        xlims!([ax1, ax2, ax3], -2, 52)
25        #ylims!(ax1, -0.17, 1.05)
26        ax1.xticks = 0:10:100
27        ax2.xticks = 0:10:100
28        ax3.xticks = 0:10:100
29        ax1.yticks = -1:0.25:1
30        ax2.yticks = -1:0.25:1
31        ax3.yticks = -1:0.25:1
32        ax1.xticklabelsvisible = false
33        ax2.xticklabelsvisible = false
34
35
36        Legend(fig[0,1], ax1;
37            orientation=:horizontal, nbanks=2,
38            width=Relative(1))
39        text!(ax1, 30.0, 1.0;
40            text=L"\Delta=0, \alpha=0.5, \
41            f=10%", align=(:center, :top))
42        text!(ax2, 30.0, 1.0;
43            text=L"\Delta=2, \alpha=0.5, \
44            f=10%", align=(:center, :top))
45        text!(ax3, 30.0, 1.0;
46            text=L"\Delta=4, \alpha=0.5, \
47            f=10%", align=(:center, :top))
48
49        Label(fig[1,1]; text="(a)",
50            tellwidth=false, tellheight=false,
51            alignmode=Mixed(;left=-70, bottom=6))
52        Label(fig[2,1]; text="(b)",
53            tellwidth=false, tellheight=false,
54            alignmode=Mixed(;left=-70, bottom=6))
55        Label(fig[3,1]; text="(c)",
56            tellwidth=false, tellheight=false,
57            alignmode=Mixed(;left=-70, bottom=6))

```

```
fig  
end  
end |> save_and_display("fig8")
```

Fig. 9: XXZ Magnetization f=10%, $\alpha=6$



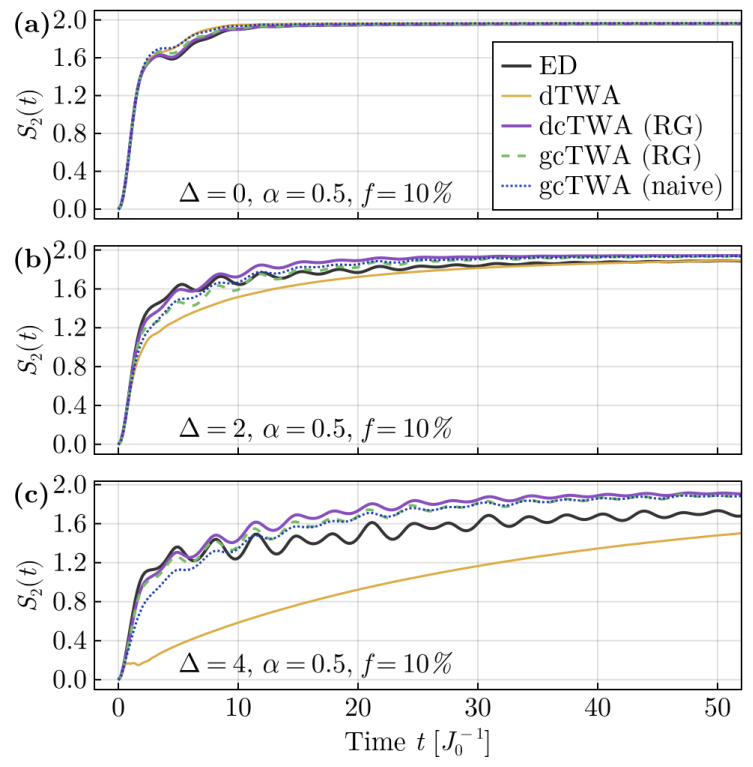
```

1 with_theme(THEME) do
2     let fig = Figure(),
3         ax1 = Axis(fig[1,1];
4             ylabel=L"\langle M^{st}(t)\rangle"
5             make_plot_section12!(ax1,
6                 @rsubset(df_avg, :α == 6,
7                     :filling == 0.1, :Δ == 0),
8                     :magnetization_mean,
9                     :magnetization_eom_full)
10        ax2 = Axis(fig[2,1];
11            ylabel=L"\langle M^{st}(t)\rangle"
12            make_plot_section12!(ax2,
13                @rsubset(df_avg, :α == 6,
14                    :filling == 0.1, :Δ == 2),
15                    :magnetization_mean,
16                    :magnetization_eom_full)
17        ax3 = Axis(fig[3,1]; xlabel=L"Time
18            $t$ $[J_0^{-1}]$", ylabel=L"\langle M^{st}(t)\rangle"
19            make_plot_section12!(ax3,
20                @rsubset(df_avg, :α == 6,
21                    :filling == 0.1, :Δ == 4),
22                    :magnetization_mean,
23                    :magnetization_eom_full)
24        xlims!([ax1, ax2, ax3], -2, 102)
25        ylims!([ax1, ax2, ax3], 0.5, 1.02)
26        ax1.xticks = 0:20:100
27        ax2.xticks = 0:20:100
28        ax3.xticks = 0:20:100
29        ax1.yticks = -1:0.2:1
30        ax2.yticks = -1:0.2:1
31        ax3.yticks = -1:0.2:1
32        ax1.xticklabelsvisible = false
33        ax2.xticklabelsvisible = false
34        #Legend(fig[3,1], ax; )
35        #axislegend(ax1; position=:lb,
36            orientation=:horizontal, nbanks=2)
37        Legend(fig[0,1], ax1;
38            orientation=:horizontal, nbanks=2,
39            width=Relative(1))
40        text!(ax1, 0.0, 0.57;
41            text=L"\Delta=0,\ \alpha=6,\ f=10%",
42            align=(left,center))
43        text!(ax2, 0.0, 0.57;
44            text=L"\Delta=2,\ \alpha=6,\ f=10%",
45            align=(left,center))
46        text!(ax3, 0.0, 0.57;
47            text=L"\Delta=4,\ \alpha=6,\ f=10%",
48            align=(left,center))
49
50        Label(fig[1,1]; text="(a)",
51            tellwidth=false, tellheight=false,
52            alignmode=Mixed(;left=-55, bottom=6))
53        Label(fig[2,1]; text="(b)",
54            tellwidth=false, tellheight=false,
55            alignmode=Mixed(;left=-55, bottom=6))
56        Label(fig[3,1]; text="(c)",

```

```
tellwidth=false, tellheight=false,  
alignmode=Mixed(;left=-55, bottom=6))  
  
fig  
end  
end |> save_and_display("fig9")
```

**Fig. 10: XXZ Renyi $f=10\%$,
 $\alpha=0.5$**



```

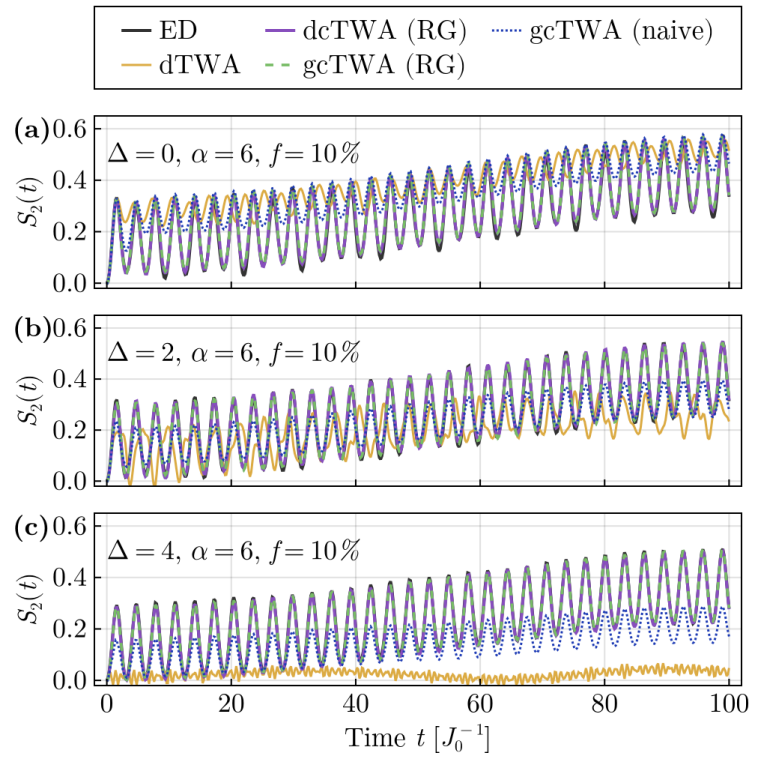
1 with_theme(THEME) do
2     let fig = Figure(),
3         ax1 = Axis(fig[1,1]; ylabel=L"S_{2}
4             (t)")
5         make_plot_section12!(ax1,
6             @rsubset(df_avg, :α == 0.5,
7                 :filling == 0.1, :Δ == 0),
8                 :pair_renyi2_mean,
9                 :pair_renyi2_eom)
10        ax2 = Axis(fig[2,1]; ylabel=L"S_{2}
11            (t)")
12        make_plot_section12!(ax2,
13            @rsubset(df_avg, :α == 0.5,
14                :filling == 0.1, :Δ == 2),
15                :pair_renyi2_mean,
16                :pair_renyi2_eom)
17        ax3 = Axis(fig[3,1]; xlabel=L"Time
18            $t$ $[J_0^{-1}]$", ylabel=L"S_{2}
19            (t)")
20        make_plot_section12!(ax3,
21            @rsubset(df_avg, :α == 0.5,
22                :filling == 0.1, :Δ == 4),
23                :pair_renyi2_mean,
24                :pair_renyi2_eom)
25        xlims!([ax1, ax2, ax3], -2, 52)
26        ylims!(ax1; high=2.1) # ensure ytick
27        at 2.0 does not clip
28        ax1.xticks = 0:10:100
29        ax2.xticks = 0:10:100
30        ax3.xticks = 0:10:100
31        ax1.yticks = -0:0.4:2
32        ax2.yticks = -0:0.4:2
33        ax3.yticks = -0:0.4:2
34        ax1.xticklabelsvisible = false
35        ax2.xticklabelsvisible = false
36        #Legend(fig[3,1], ax; )
37        axislegend(ax1; position=:rb,
            rowgap=0)
            text!(ax1, 5.0, 0.02;
            text=L"\Delta=0, \alpha=0.5, \
            f=10%", align=(:left,:bottom))
            text!(ax2, 5.0, 0.02;
            text=L"\Delta=2, \alpha=0.5, \
            f=10%", align=(:left,:bottom))
            text!(ax3, 5.0, 0.02;
            text=L"\Delta=4, \alpha=0.5, \
            f=10%", align=(:left,:bottom))

            Label(fig[1,1]; text="(a)",
            tellwidth=false, tellheight=false,
            alignmode=Mixed(;left=-55, bottom=6))
            Label(fig[2,1]; text="(b)",
            tellwidth=false, tellheight=false,
            alignmode=Mixed(;left=-55, bottom=6))
            Label(fig[3,1]; text="(c)",
            tellwidth=false, tellheight=false,
            alignmode=Mixed(;left=-55, bottom=6))

```

```
fig
end
end |> save_and_display("fig10")
```

**Fig. 11: XXZ Renyi $f=10\%$,
 $\alpha=6$**



```

1 with_theme(THEME) do
2     let fig = Figure()
3
4     ax1 = Axis(fig[1,1]; ylabel=L"S_{2}
5         (t)")
6     make_plot_section12!(ax1,
7         @rsubset(df_avg, :α == 6,
8             :filling == 0.1, :Δ == 0),
9             :pair_renyi2_mean,
10            :pair_renyi2_eom)
11    ax2 = Axis(fig[2,1]; ylabel=L"S_{2}
12        (t)")
13    make_plot_section12!(ax2,
14        @rsubset(df_avg, :α == 6,
15            :filling == 0.1, :Δ == 2),
16            :pair_renyi2_mean,
17            :pair_renyi2_eom)
18    ax3 = Axis(fig[3,1]; xlabel=L"Time
19        $t$ $[J_0^{-1}]$", ylabel=L"S_{2}
20        (t)")
21    make_plot_section12!(ax3,
22        @rsubset(df_avg, :α == 6,
23            :filling == 0.1, :Δ == 4),
24            :pair_renyi2_mean,
25            :pair_renyi2_eom)
26
27    xlims!([ax1, ax2, ax3], -2, 102)
28    ylims!([ax1, ax2, ax3], -0.02, 0.65)
29
30    ax1.xticks = 0:20:100
31    ax2.xticks = 0:20:100
32    ax3.xticks = 0:20:100
33    ax1.yticks = -1:0.2:1
34    ax2.yticks = -1:0.2:1
35    ax3.yticks = -1:0.2:1
36    ax1.xticklabelsvisible = false
37    ax2.xticklabelsvisible = false
38
39    Legend(fig[0,1], ax1;
40        orientation=:horizontal, nbanks=2,
41        width=Relative(1))
42
43    text!(ax1, 0.0, 0.45;
44        text=L"\Delta=0, \alpha=6, f=10%",
45        align=(:left, :bottom))
46    text!(ax2, 0.0, 0.45;
47        text=L"\Delta=2, \alpha=6, f=10%",
48        align=(:left, :bottom))
49    text!(ax3, 0.0, 0.45;
50        text=L"\Delta=4, \alpha=6, f=10%",
51        align=(:left, :bottom))
52
53    Label(fig[1,1]; text="(a)",
54        tellwidth=false, tellheight=false,
55        alignmode=Mixed(;left=-55, bottom=6))
56    Label(fig[2,1]; text="(b)",
57        tellwidth=false, tellheight=false,

```

```
alignmode=Mixed(;left=-55, bottom=6))
Label(fig[3,1]; text="(c)",
tellwidth=false, tellheight=false,
alignmode=Mixed(;left=-55, bottom=6))

fig
end
end |> save_and_display("fig11")
```

Section 1: ordered

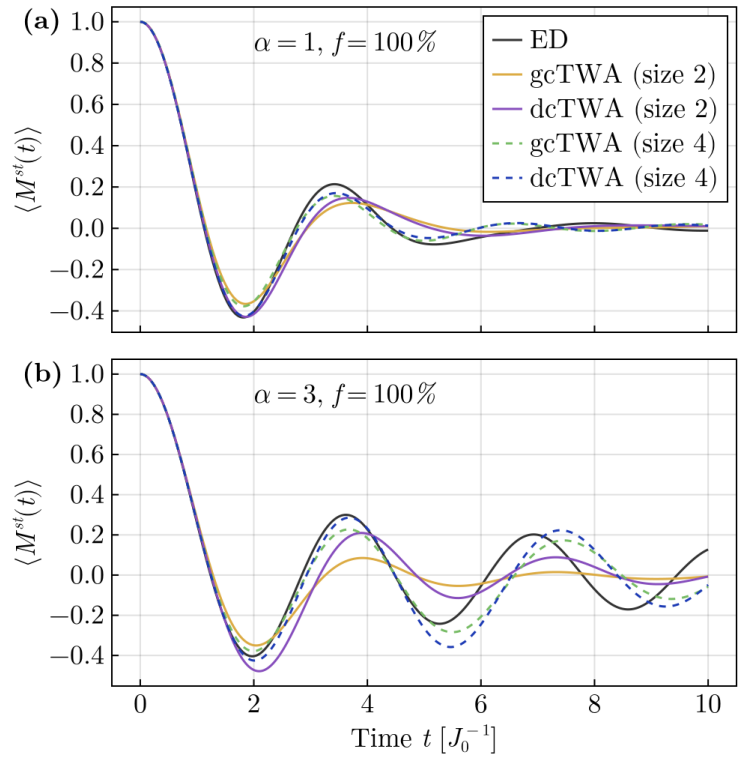
	clustersize	N	α	Δ	tlist
1	missing	16	1.0	0	0.0:0.02:
2	2	16	1.0	0	0.0:0.02:
3	4	16	1.0	0	0.0:0.02:
4	missing	16	1.0	0	0.0:0.02:
5	2	16	1.0	0	0.0:0.02:
6	4	16	1.0	0	0.0:0.02:

```
1 sort(@rsubset(df_avg, : $\alpha$  == 1, :filling ==  
1, : $\Delta$  == 0), [:alg, :clustersize])
```

Fig. 5 Magnetization/Renyi ordered

lines_with_band! (generic function with 1 method)

```
1 function lines_with_band!(ax, x, y, err;  
2 color, label=nothing, linestyle=:solid,  
3 line_kwargs=(;), band_kwargs=(;))  
4     band!(ax, x, y .- err, y .+ err;  
        alpha=0.5, color, band_kwargs...)  
        lines!(ax, x, y; color, label,  
        linestyle, line_kwargs...)  
end
```




```

1 with_theme(THEME) do
2     let fig = Figure()
3
4     ax1 = Axis(fig[1,1];
5     ylabel=L"\langle M^{st}(t)\rangle"
6     _, d2, d4, ed, g2, g4 =
7     eachrow(sort(@rsubset(df_avg, :α ==
8     1, :filling == 1, :Δ == 0), [:alg,
9     :clustersize]))
10    lines!(ax1, ed.tlist,
11    ed.magnetization_mean;
12    color=section1_palette.ed,
13    label="ED")
14    lines!(ax1, g2.tlist,
15    g2.magnetization_mean;
16    color=section1_palette.dTWA,
17    label="gcTWA (size 2)")
18    lines!(ax1, d2.tlist,
19    d2.magnetization_mean;
20    color=section1_palette.rg_dcTWA,
21    label="dcTWA (size 2)")
22    lines!(ax1, g4.tlist,
23    g4.magnetization_mean;
24    color=section1_palette.rg_gcTWA,
25    label="gcTWA (size 4)",
26    linestyle=:dash)
27    lines!(ax1, d4.tlist,
28    d4.magnetization_mean;
29    color=section1_palette.naive_gcTW
30    A,
31    label="dcTWA (size 4)",
32    linestyle=:dash)
33
34    ax2 = Axis(fig[2,1]; xlabel=L"Time
35    $t$ $[J_0^{-1}]$", ylabel=L"\langle
36    M^{st}(t)\rangle"
37    _, d2, d4, ed, g2, g4 =
38    eachrow(sort(@rsubset(df_avg, :α ==
39    3, :filling == 1, :Δ == 0), [:alg,
40    :clustersize]))
41    lines!(ax2, ed.tlist,
42    ed.magnetization_mean;
43    color=section1_palette.ed,
44    label="ED")

```

```

45 lines!(ax2, g2.tlist,
46 g2.magnetization_mean;
47 color=section1_palette.dTWA,
48 label="gcTWA (size 2)")
49 lines!(ax2, d2.tlist,
50 d2.magnetization_mean;
51 color=section1_palette.rg_dcTWA,
52 label="dcTWA (size 2)")
53 lines!(ax2, g4.tlist,
54 g4.magnetization_mean;
55 color=section1_palette.rg_gcTWA,
56 label="gcTWA (size 4)",
57 linestyle=:dash)
58 lines!(ax2, d4.tlist,
59 d4.magnetization_mean;
color=section1_palette.naive_gcTWA,
label="dcTWA (size 4)",
linestyle=:dash)

ax1.xticklabelsvisible = false
ax1.xticks = 0:2:10
ax2.xticks = 0:2:10
ax1.yticks = -0.4:0.2:1
ax2.yticks = -0.4:0.2:1

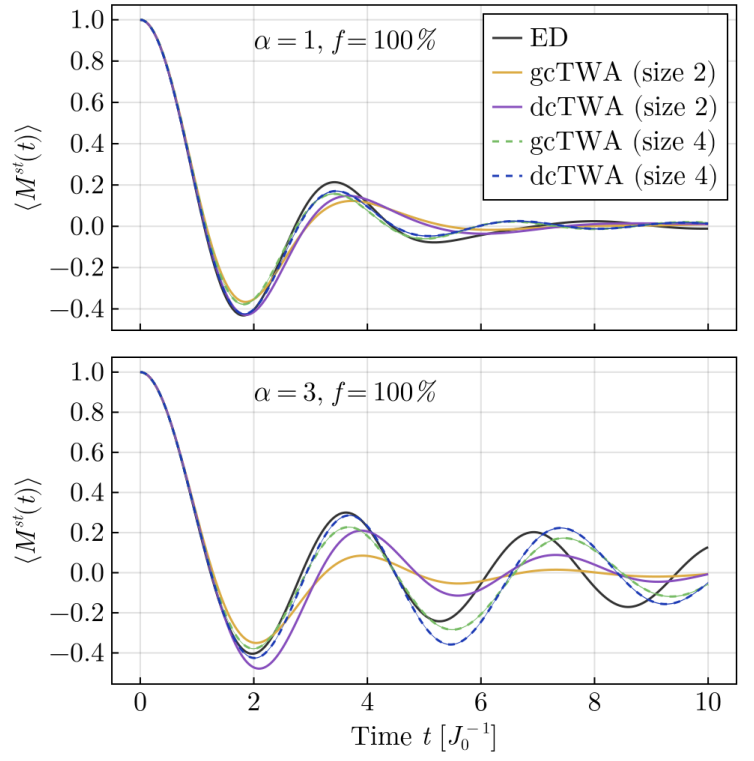
axislegend(ax1; position=:rt)

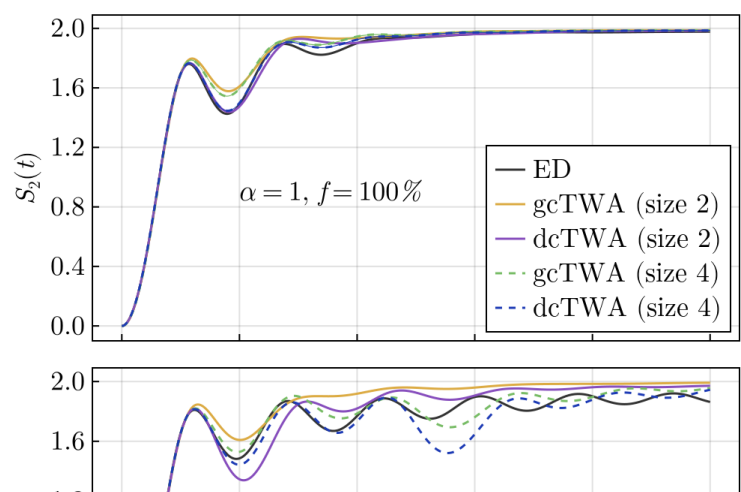
text!(ax1, 2.0, 0.9; text=L"\alpha=1,
\ f=100%", align=(left,center))
text!(ax2, 2.0, 0.9; text=L"\alpha=3,
\ f=100%", align=(left,center))

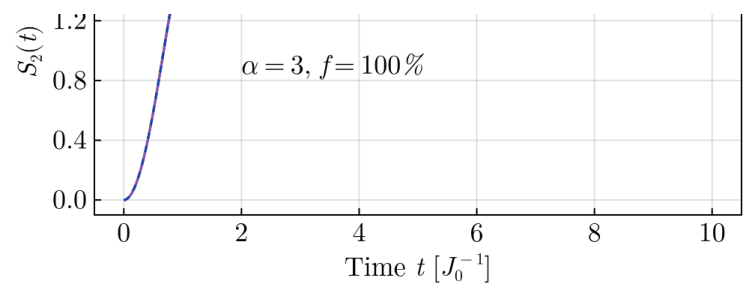
Label(fig[1,1]; text="(a)",
tellwidth=false, tellheight=false,
alignmode=Mixed(;left=-60, bottom=6))
Label(fig[2,1]; text="(b)",
tellwidth=false, tellheight=false,
alignmode=Mixed(;left=-60, bottom=6))
fig
end
end |> save_and_display("fig5")

```


With statistical error as ribbon:








```

1 with_theme(THEME) do
2     let fig = Figure(),
3         ax1 = Axis(fig[1,1]; ylabel=L"S_{2}
4             (t)")
5         _, d2, d4, ed, g2, g4 =
6         eachrow(sort(@rsubset(df_avg, :α ==
7             1, :filling == 1, :Δ == 0), [:alg,
8             :clustersize]))
9         lines!(ax1, ed.tlist,
10            ed.pair_renyi2_mean;
11            color=section1_palette.ed,
12            label="ED")
13         lines_with_band!(ax1, g2.tlist,

```

```

14     g2.pair_renyi2_mean,
15     g2.magnetization_eom_syst;
16     color=section1_palette.dTWA,
17     label="gcTWA (size 2)")
18 lines!(ax1, d2.tlist,
19     d2.pair_renyi2_mean;
20     color=section1_palette.rg_dcTWA,
21     label="dcTWA (size 2)")
22 lines_with_band!(ax1, g4.tlist,
23     g4.pair_renyi2_mean,
24     g4.magnetization_eom_syst;
25     color=section1_palette.rg_gcTWA,
26     label="gcTWA (size 4)",
27     linestyle=:dash)
28 lines_with_band!(ax1, d4.tlist,
29     d4.pair_renyi2_mean,
30     d4.magnetization_eom_syst;
31     color=section1_palette.naive_gcTWA,
32     label="dcTWA (size 4)",
33     linestyle=:dash)
34
35
36 ax2 = Axis(fig[2,1]; xlabel=L"Time
37 $t$  $J_0^{-1}$ ", ylabel=L"$S_{\{2\}}(t)$")
38
39 _, d2, d4, ed, g2, g4 =
40 eachrow(sort(@rsubset(df_avg, :α ==
41 3, :filling == 1, :Δ == 0), [:alg,
42 :clustersize]))
43 lines!(ax2, ed.tlist,
44     ed.pair_renyi2_mean;
45     color=section1_palette.ed,
46     label="ED")
47 lines!(ax2, g2.tlist,
48     g2.pair_renyi2_mean;
49     color=section1_palette.dTWA,
50     label="gcTWA (size 2)")
51 lines!(ax2, d2.tlist,
52     d2.pair_renyi2_mean;
53     color=section1_palette.rg_dcTWA,
54     label="dcTWA (size 2)")
55 lines!(ax2, g4.tlist,
56     g4.pair_renyi2_mean;
57     color=section1_palette.rg_gcTWA,
58     label="gcTWA (size 4)",
59     linestyle=:dash)
60 lines!(ax2, d4.tlist,
61     d4.pair_renyi2_mean;
62     color=section1_palette.naive_gcTWA,
63     label="dcTWA (size 4)",
64     linestyle=:dash)
65
66 ax1.xticklabelsvisible = false
67 ax1.xticks = 0:2:10
68 ax2.xticks = 0:2:10
69 ax1.yticks = -0.4:0.4:2
70 ax2.yticks = -0.4:0.4:2

```

```
ax2.y_ticks = 70.4.0.4.2

axislegend(ax1; position=:rb)

text!(ax1, 2.0, 0.9; text=L"\alpha=1,
\ f=100%", align=(:left,:center))
text!(ax2, 2.0, 0.9; text=L"\alpha=3,
\ f=100%", align=(:left,:center))
fig
end
end
```


Section 3: Statistics

data_full_raw =

	clustersize	Δ	N	tlist	a
1	2	0	16	0.0:0.02:10.0	"dc
2	4	0	16	0.0:0.02:10.0	"dc
3	2	0	16	0.0:0.02:10.0	"gc
4	4	0	16	0.0:0.02:10.0	"gc

```
1 data_full_raw = @chain collect_results("../
2 data/fulldata-simulations-avg") begin
3   @rtransform(
4     :magnetization_mean =
5     :results[1].magnetization_mean,
6     :magnetization_std =
7     :results[1].magnetization_std,
8     :renyi_means =
9     :results[1].renyi_means,
10    :renyi_stds = :results[1].renyi_stds,
11    :renyi_chunksizes =
      :results[1].renyi_chunksizes)
    select!(Not([:path, :results, :chunkID,
      :fulldata]))
    @rsubset(:α == 1)
    sort!([:alg, :clustersize])
  end
```

Scanning folder ../data/fulldata-simulations-avg for result files.

Added 8 entries.

0.06666666666666667

```
1 8/binomial(16,2)
```

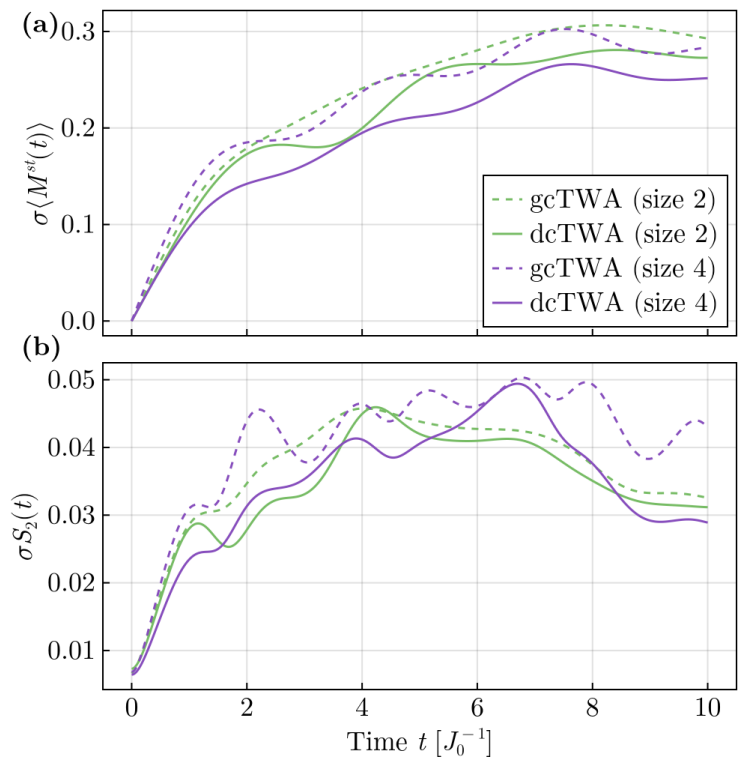
Fig. 12: Stddev of magnetization

```
1 let (d2,d4,g2,g4) = eachrow(data_full_raw)
2   f2 = sum(d2.magnetization_std)/
3       sum(g2.magnetization_std)
4   println("1-D2/G2: ", 1-f2, " -> ", 1-
5           f2^2)
6   f4 = sum(d4.magnetization_std)/
7       sum(g4.magnetization_std)
8   println("1-D4/G4: ", 1-f4, " -> ", 1-
9           f4^2)
end
```

```
1-D2/G2: 0.08781249218184817 -> 0.16 ②
791395058050917
1-D4/G4: 0.15220239597046392 -> 0.28123
92226017779
```

```
1 let (d2,d4,g2,g4) = eachrow(data_full_raw)
2   f2 = sum(d2.renyi_stds[2])/
3       sum(g2.renyi_stds[2])
4   println("1-D2/G2: ", 1-f2, " -> ", 1-
5           f2^2)
6   f4 = sum(d4.renyi_stds[2])/
7       sum(g4.renyi_stds[2])
8   println("1-D4/G4: ", 1-f4, " -> ", 1-
9           f4^2)
end
```

```
1-D2/G2: 0.07133043568079023 -> 0.13 ②
75728403071691
1-D4/G4: 0.15757606419565506 -> 0.29032
19123839169
```


```

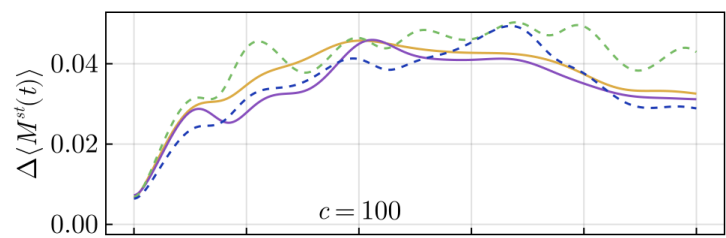
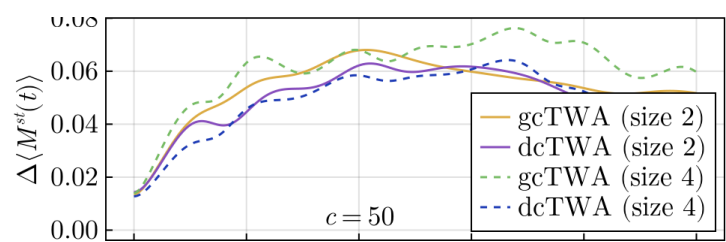
1 with_theme(THEME) do
2     let fig = Figure()
3
4     ax1 = Axis(fig[1,1];
5     ylabel=L"\sigma\langle M^{\text{st}}
6     (t)\rangle")
7     d2,d4,g2,g4 = eachrow(data_full_raw)
8     lines!(ax1, g2.tlist,
9     g2.magnetization_std;
10     color=section1_palette.rg_gcTWA,
11     label="gcTWA (size 2)",
12     linestyle=:dash)
13     lines!(ax1, d2.tlist,

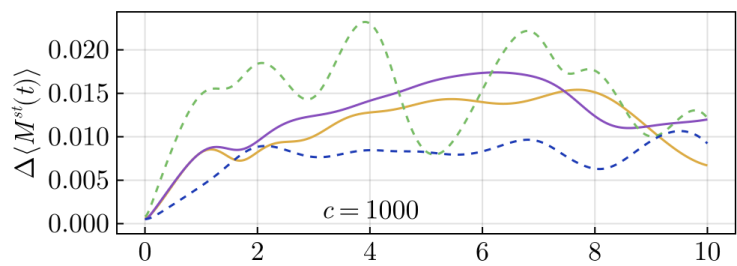
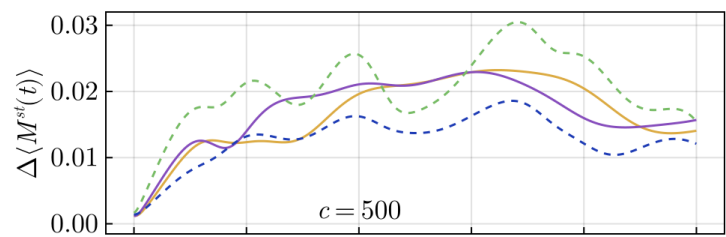
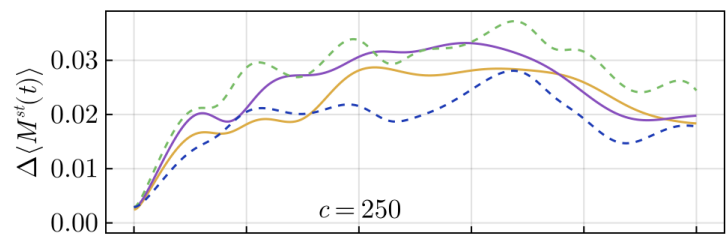
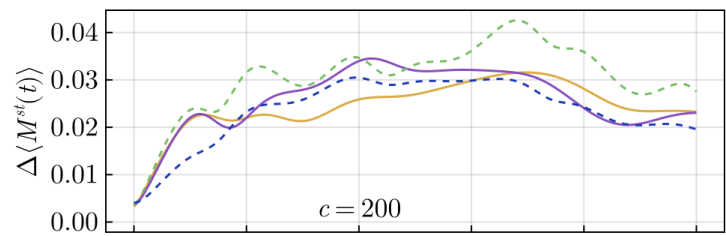
```

```

14     d2.magnetization_std;
15     color=section1_palette.rg_gcTWA,
16     label="dcTWA (size 2)")
17 lines!(ax1, g4.tlist,
18 g4.magnetization_std;
19     color=section1_palette.rg_dcTWA,
20     label="gcTWA (size 4)",
21     linestyle=:dash)
22 lines!(ax1, d4.tlist,
23 d4.magnetization_std;
24     color=section1_palette.rg_dcTWA,
25     label="dcTWA (size 4)")
26
27 ax2 = Axis(fig[2,1]; xlabel=L"Time
28 $t$  $[J_0^{-1}]$ ", ylabel=L"\sigma
29 S_2(t)")
30 lines!(ax2, g2.tlist,
31 g2.renyi_stds[2];
32     color=section1_palette.rg_gcTWA,
33     label="gcTWA (size 2)",
34     linestyle=:dash)
35 lines!(ax2, d2.tlist,
36 d2.renyi_stds[2];
37     color=section1_palette.rg_gcTWA,
38     label="dcTWA (size 2)")
39 lines!(ax2, g4.tlist,
40 g4.renyi_stds[2];
41     color=section1_palette.rg_dcTWA,
42     label="gcTWA (size 4)",
43     linestyle=:dash)
44 lines!(ax2, d4.tlist,
45 d4.renyi_stds[2];
46     color=section1_palette.rg_dcTWA,
47     label="dcTWA (size 4)")
48
49
50 ax1.xticklabelsvisible = false
51 ax1.xticks = 0:2:10
52 ax2.xticks = 0:2:10
53
54 axislegend(ax1; position=:rb)
55
56 Label(fig[1,1]; text="(a)",
57 tellwidth=false, tellheight=false,
58 alignmode=Mixed(;left=-55, bottom=6))
59 Label(fig[2,1]; text="(b)",
60 tellwidth=false, tellheight=false,
61 alignmode=Mixed(;left=-55,
62 bottom=26))
63 fig
64 end
65 end |> save_and_display("fig12")

```

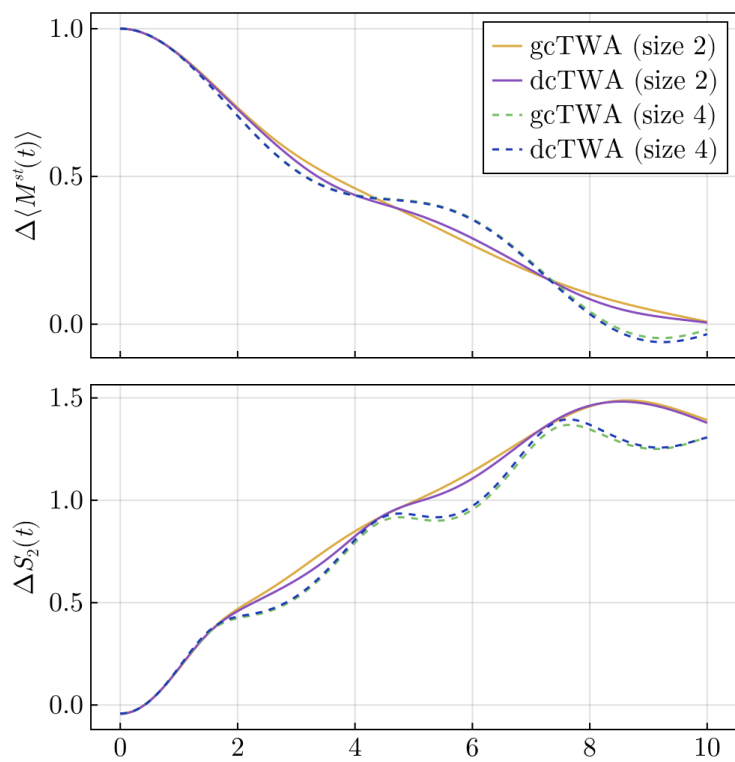






```

1 with_theme(THEME) do
2     let fig = Figure(;
3         size=(246*SCALE,2*HEIGHT*SCALE)),
4         (d2,d4,g2,g4) =
5         eachrow(data_full_raw),
6         axes = []
7         for (i, chunksize) in
8             enumerate(d2.renyi_chunksizes)
9             ax = Axis(fig[i,1];
10                ylabel=L"\Delta\langl M^{\st}
11                (t)\rangl")
12                push!(axes, ax)
13                ax.xticklabelsvisible = false
14                ax.xticks = 0:2:10
15
16                lines!(ax, g2.tlist,
17                    g2.renyi_stds[i];
18                    color=section1_palette.dTWA,
19                    label="gcTWA (size 2)")
20                lines!(ax, d2.tlist,
21                    d2.renyi_stds[i];
22                    color=section1_palette.rg_dcT
23                    WA,
24                    label="dcTWA (size 2)")
25                lines!(ax, g4.tlist,
26                    g4.renyi_stds[i];
27                    color=section1_palette.rg_gcT
28                    WA,
29                    label="gcTWA (size 4)",
30                    linestyle=:dash)
31                lines!(ax, d4.tlist,
32                    d4.renyi_stds[i];
33                    color=section1_palette.naive_
34                    gcTWA,
35                    label="dcTWA (size 4)",
36                    linestyle=:dash)
37                text!(ax, 4, 0; text=L"c=%
38                $chunksize",
39                align=(:center,:bottom))
40            end
41            axes[end].xticklabelsvisible = true
42
43            axislegend(axes[1]; position=:rb,
44                rowgap=0)
45            fig
46        end
47    end
48    end# |> save_and_display("fig12")

```


```

1 with_theme(THEME) do
2     let fig = Figure(),
3         ax1 = Axis(fig[1,1];
4             ylabel=L"\Delta\langle M^{\text{st}}
5             (t)\rangle")
6         d2,d4,g2,g4 = eachrow(data_full_raw)
7         lines!(ax1, g2.tlist,
8             g2.magnetization_mean;
9             color=section1_palette.dTWA,
10             label="gcTWA (size 2)")
11         lines!(ax1, d2.tlist,
12             d2.magnetization_mean;
13             color=section1_palette.rg_dcTWA,
14             label="dcTWA (size 2)")
15         lines!(ax1, g4.tlist,
16             g4.magnetization_mean;
17             color=section1_palette.rg_gcTWA,
18             label="gcTWA (size 4)",
19             linestyle=:dash)
20         lines!(ax1, d4.tlist,
21             d4.magnetization_mean;
22             color=section1_palette.naive_gcTWA,
23             label="dcTWA (size 4)",
24             linestyle=:dash)
25
26
27         ax2 = Axis(fig[2,1]; ylabel=L"\Delta
28             S_2(t)")
29         lines!(ax2, g2.tlist,
30             g2.renyi_means[2];
31             color=section1_palette.dTWA,
32             label="gcTWA (size 2)")
33         lines!(ax2, d2.tlist,
34             d2.renyi_means[2];
35             color=section1_palette.rg_dcTWA,
36             label="dcTWA (size 2)")
37         lines!(ax2, g4.tlist,
38             g4.renyi_means[2];
39             color=section1_palette.rg_gcTWA,
40             label="gcTWA (size 4)",
41             linestyle=:dash)
42         lines!(ax2, d4.tlist,
43             d4.renyi_means[2];
44             color=section1_palette.naive_gcTWA

```

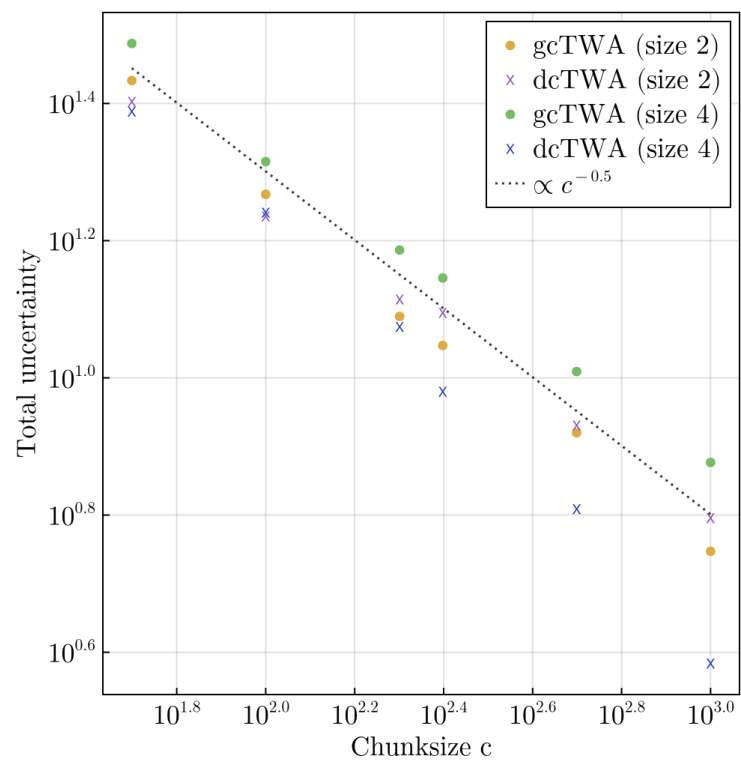
```

45         A,
46         label="dcTWA (size 4)",
47         linestyle=:dash)
48
ax1.xticksvisible = false
ax1.xticks = 0:2:10
ax2.xticks = 0:2:10
# ax1.yticks = -0.4:0.2:1
# ax2.yticks = -0.4:0.2:1

axislegend(ax1; position=:rt)

# text!(ax1, 2.0, 0.9;
# text=L"\alpha=1,\ f=100%",
# align=(left,center))
# text!(ax2, 2.0, 0.9;
# text=L"\alpha=3,\ f=100%",
# align=(left,center))
fig
end
end# |> save_and_display("fig12")

```


```

1 with_theme(THEME) do
2     let fig = Figure(),
3         ax1 = Axis(fig[1,1]; ylabel="Total
4         uncertainty", xlabel="Chunksize c",
5         xscale=log10, yscale=log10)
6     d2,d4,g2,g4 = eachrow(data_full_raw)
7     scatter!(ax1, g2.renyi_chunksizes,
8     sum.(g2.renyi_stdts);
9         color=section1_palette.dTWA,
10        label="gcTWA (size 2)")
11    scatter!(ax1, d2.renyi_chunksizes,
12    sum.(d2.renyi_stdts);
13        color=section1_palette.rg_dcTWA,

```

```

14         label="dcTWA (size 2)",
15         marker='X')
16     scatter!(ax1, g4.renyi_chunksizes,
17             sum.(g4.renyi_stds);
18             color=section1_palette.rg_gcTWA,
19             label="gcTWA (size 4)")
20     scatter!(ax1, d4.renyi_chunksizes,
21             sum.(d4.renyi_stds);
22             color=section1_palette.naive_gcTW
23             A,
24             label="dcTWA (size 4)",
25             marker='X')
26     lines!(ax1, d4.renyi_chunksizes, x-
27           >200/√(x); label=L"\propto
28           c^{-0.5}",
29           color=section1_palette.ed,
30           linestyle=:dot)
31
32
33     # ax1.xticklabelsvisible = false
34     # ax1.xticks = 0:2:10
35     ax1.yticks = (10 .^ (0.6:0.2:1.4),
36                 [L"10^{%$x}" for x in (0.6:0.2:1.4)])
37     ax1.xticks = (10 .^ (1.6:0.2:3),
38                 [L"10^{%$x}" for x in (1.6:0.2:3)])
39     # ax2.yticks = -0.4:0.2:1
40
41     axislegend(ax1; position=:rt)
42
43     # text!(ax1, 2.0, 0.9;
44     text=L"\alpha=1,\ f=100%",
45     align=(left,center))
46     # text!(ax2, 2.0, 0.9;
47     text=L"\alpha=3,\ f=100%",
48     align=(left,center))
49     fig
50 end
51 end# |> save_and_display("fig12")

```